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Chemical quality of drinking water for livestock under organized and unorganized sectors in the Brahmaputra Valley of Assam

J Rahman, LJ Kakati, NF Illiash, KJ Thakuria, N Bezbaruah and RU Ahmed

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J Rahman
M.V.Sc., Department of LPM, C.V.Sc., AAU, Khanapara, Guwahati, Assam, India

LJ Kakati
Ph.D. Scholar, Department of LPM, C.V.Sc., AAU, Khanapara, Guwahati, Assam, India

NF Illiash
Veterinary Officer, Animal Husbandry and Veterinary Department, Govt. of Assam, India

KJ Thakuria
Senior Research Fellow, Department of LPT, C.V.Sc., AAU, Khanapara, Guwahati, Assam, India

N Bezbaruah
M.V. Sc., Department of ANN, C.V. Sc., AAU, Khanapara, Guwahati, Assam, India

RU Ahmed
M.V.Sc., Department of LPM, C.V.Sc., AAU, Khanapara, Guwahati, Assam, India

Corresponding Author:
J Rahman
M.V.Sc., Department of LPM, C.V.Sc., AAU, Khanapara, Guwahati, Assam, India

Abstract
A total of sixty (60) samples from organized and unorganized sectors were collected in five different districts of the Brahmaputra Valley of Assam. Six (6) samples were collected each from organized and unorganized farms from one district. The water samples were assessed with the help of water testing kit (Jaltara water testing kit-TARA life sustainability Solution Private Limited, New Delhi, India). The results of the chemical parameters namely pH, TDS, total hardness, arsenic chloride, fluoride, nitrate and sulfate showed that the concentration of these parameters were below or within the guideline limit. It can be concluded that the water samples were found to be safe for consumption while the iron concentration was higher both in the organized and unorganized sectors of all the selected districts where Kamrup (R) and Nagaon bear the highest concentration among all the selected districts.

Keywords: Livestock, water, chemical quality, Brahmaputra Valley, Assam

Introduction
India is an agriculture based country where animal husbandry plays an important role in Indian agriculture. Most of the rural populations in India are dependent on agriculture and animal husbandry is one of the important source of income, employment opportunities and nutrition.
Water is vital to all life forms and is the most important nutrient for livestock and other living organisms as well. It is also involved in many essential physiological functions, such as digestion, absorption, enzymatic function, nutrient transportation, thermoregulation, lubrication of joint and organs, elimination of waste. Total body water content of adult cattle ranges between 56-81% of body weight (Murphy, 1992) [5]. In addition to managemental practices, it is very much important to assess the quality of feed, fodder and water to ensure a healthy livestock unit.
Water is a good medium for spread of numerous diseases and so it requires proper assessment and adequate treatment whenever necessary. For efficient livestock production a continuous supply of clean, fresh and wholesome potable water is always essential. Though water is essential for life and other functions as well, the same need to be clean, fresh and wholesome, and free of toxic components. Excessive concentrations of heavy metals are detrimental. They destabilize ecosystems because of their bioaccumulation in organisms, and toxic effects on biota and even death in most living beings. All heavy metals, in spite some of them are essential micronutrients, have their toxic effects on living organisms via metabolic interference and mutagenesis. The bioaccumulation of toxic metals can occur in the body and food chain. So, the toxic metals generally exhibit chronic toxicity [Pandey and Madhuri (2014) [1]]. One of the important sources of heavy metals is water through which it finds its way to animal's body. Certain heavy metals even in very low concentration may cause detrimental effect in an animal.
Ground water Arsenic (As) and Iron (Fe) contamination in the Brahmaputra river basin were recorded as 0.128 ppm and 5.9 ppm respectively which was above the WHO drinking water guideline values. In the Brahmaputra alluvial plains of Assam, fluoride content has been reported by many researchers in the district of Kamrup, Karbi Anglong, Golaghat, Guwahati. Kalita (2015) [2] studied the quality of drinking water in Palashbari area of Kamrup rural district in Assam where concentration of fluoride and iron exceeded the WHO (2011) [4] permissible limit.

Many researchers have shown that water has got important impact on animal health and production performances. It was found that the pH of all the water samples collected from different states were in the range of 6.0-8.3, 5.5-7.4, 6.4-8.7, 4.0-8.0, 4.8-7.4, 5.8-8.0, 5.1-7.2, and 4.3-8.3 in Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, respectively (Singh, 2004) [6]. It was assessed that the ground water quality of Brahmaputra plains of Assam found the pH of sediments to be slightly acidic (Sailo & Mahanta 2014) [8]. Singh (2004) [6] observed that the TDS of groundwater in North Eastern India ranged from 10-70 mg/L, 10- 249 mg/L, 10-121 mg/L, 20-360 mg/L, 10-200 mg/L, 10-115 mg/L, 80-100 mg/L and 100- 205 mg/L in Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, respectively. Maximum TDS was observed in Assam and Tripura state respectively. Chetia *et al.* (2011) [7] reported that the total hardness of drinking water from shallow and deep well in Gamariguri, Golaghat districtranged between 50.4-139.7 and found that 76.4% of the total (220) ground water samples collected from shallow and deep well in Golaghat districts of Assam samples were contaminated with iron and crossed the WHO (2011) [4] guideline value. In Gamariguri area 100% of the samples were contaminated with iron where concentration was found to be 5.9ppm. Chetia *et al.* (2011) [7] in a study in Golaghat districts of Assam found that the sulfate content (ppm) of drinking water in Gamariguri area ranged from 15.3-98.3. Kar *et al*. (2010) [3] found that the arsenic content varied between 0.0023 mg/L (winter, Middle stream) and 0.0040 mg/L (Monsoon, Reservoir) in the river. The mean arsenic values (Mean±2SD) were 0.0036 ± 0.0008, 0.0032 ± 0.0008, 0.0029 ± 0.0008 and 0.0034 ± 0.0007 in reservoir, upstream, middle stream and downstream respectively. Das and Bhattacharya (2012) [9] observed that 40% sampling stations of the study area (Kokrajhar, Assam) had fluoride content (mg/l) below detectable level and the maximum value of fluoride obtained in ring well of Gossaigaon was 0.08, mg/L. Choudhury *et al*. (2016) [10] observedthat the chloride concentration (mg/l) of Bahini river water of Guwahati were 8.32±2.87 mg/l, 13.32±2.89 mg/l, 31.65±2.88 mg/l, 56.64±2.88 mg/l at four different sites.

Considering the importance of assessment of quality of drinking water, the present study has been undertaken with the objectives to assess the chemical quality of drinking water.

Materials and Methods

The study was undertaken to find out the chemical quality of drinking water for livestock under organized (O) and unorganized (UO) sectors [farm (F)] in five different districts of the Brahmaputra Valley of Assam. Five agroclimatic zones were selected from the valley where one district was selected from each zone on the basis of livestock population. Six (6) samples were collected each from organized and unorganized farms from one district. Hence, a total of sixty (60) samples were collected from the selected districts. The water samples were assessed with the help of water testing kits (*JalTara* water testing kit by *TARA life* sustainability Solution Private Limited, New Delhi, India).

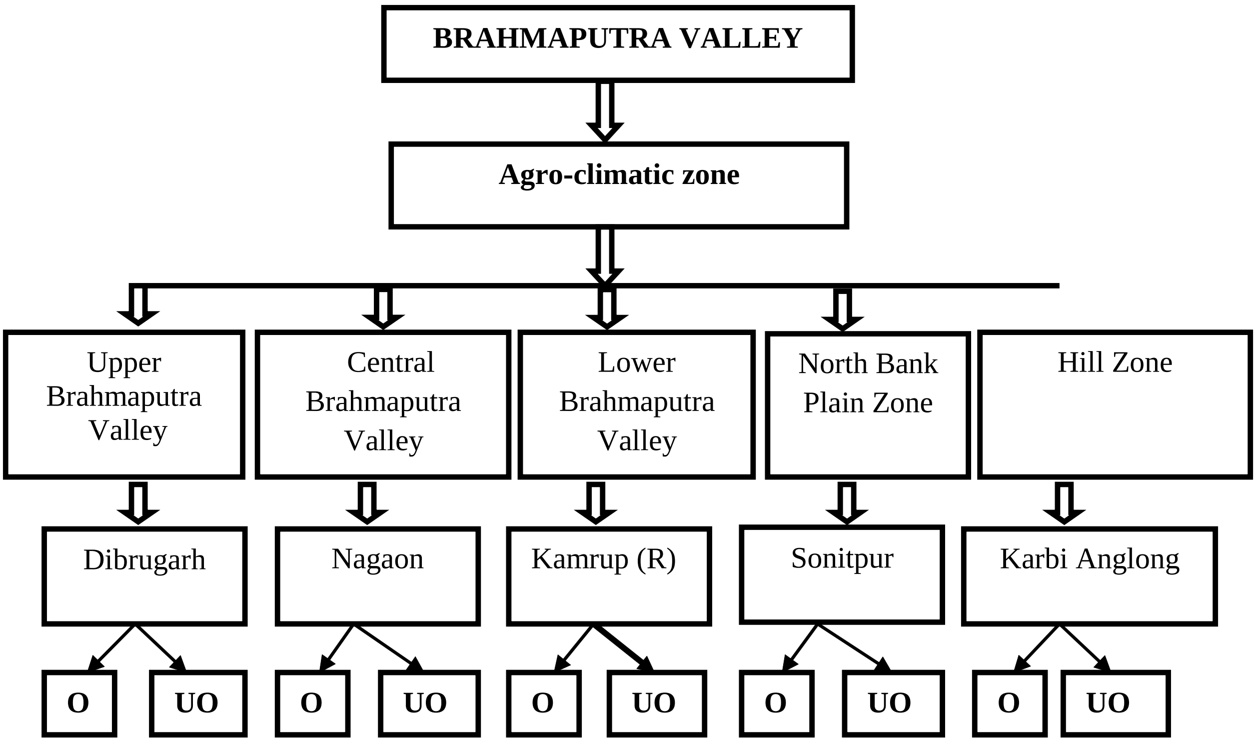

Fig 1: Diagram matic representation of collection of samples from different districts of the Brahmaputra Valley of Assam

Chemical qualities

Chemical quality (parameters) of the water samples viz., pH, total dissolved solids, total hardnesss, iron, sulfate, arsenic, fluoride, chloride, nitrate were estimated with the help of water testing kit (Jal-TARA water testing kit- 11 parameter HSN/SAC 84190000 and JalTARA Arsenic testing kit HSN/SAC 84190000, developed by TARA life sustainability Solutions Private limited, B-32 TARA Crescent, Qutub Institutional Area, New Delhi- 110016, India**)**. The pH of water samples were estimated by using digital pH meter.

The standard procedures prescribed by the Jal TARA water testing kits were followed in estimating the chemical parameters of the water samples.

Collection of water samples

The water samples of the selected districts were collected in sterile sample container directly from the point of sources. The samples had been collected hygienically wearing sterilized hand gloves to minimize any sorts of contamination. The containers with the samples inside were transported following standard protocols.

Preservation of Samples

Standard preservation protocols were followed while preserving the water samples.

Estimation of Chemical Parameter

The water samples had been evaluated with the help of JalTARA water testing kits.

pH

The pH of water samples were estimated with the help of digital pH meter.

Total dissolved solids (TDS)

TDS of water samples have been estimated with the help of digital TDS meter.

Total hardness **Reagents** 1. Amonia buffer 2. Eriochrome Black- T powder 3. EDTA	**Procedure** 1. 5ml of water sample is transferred to a test tube. 2. 1-2 drops of ammonia buffer is added to raise the ph of the sample to 10. 3. Pinch of eriochrome black-T is added to the sample. 4. 1ml of EDTA solution is taken in 1ml syringe without any air bubbles. 5. The whole solution after addition of eriochrome black – T powder is titrated against EDTA till colour changes from wine red to blue. 6. The amount of EDTA consumed is noted to calculated the value of hardness of water by using the following formula- Hardness as CaCo3 = (ml of EDTA consumed × 400) mg/l
Iron **Reagents:** 1. Fe-A 2. Fe-B	**Procedure:** 1. 20 ml of water sample is transferred in a test tube. 2. ½ spoon of reagent A is added in the water sample and the solution is shaked to dissolved the reagent. 3. ½ spoon of reagent B is added using another spoon and the solution is shaked to dissolved the reagent. 4. The colour that is developed in the solution is compared with the standard iron colour chart vertically after 5 minutes of addition of reagent B.

Sulfate Reagent 1. Sulfate-1 (liquid solution) 2. Sulfate-2 (powder)	**Procedure** a. 5ml of clear water sample is taken in a test tube. b. 1 ml of sulfate-1 is added to the sample. c. Pinch of sulfate-2 powder is added to the sample. The test tube is then shaked continuously for about a minute. d. White turbidity will be developed in the solution in proportion to the sulfate quantity. e. The test tube is then held vertically over the standard sulfate chart to matc f. h with the corresponding value.
Arsenic **Reagents** 1. Reagent As1 2. Reagent As2 3. Reagent As3	**Procedure** 1. The test strip is inserted in Arsenic generator lid hole till the mark on the strip vertically straight, with the reaction zone keeping downside. 2. The sample is taken till the mark on Arsenic generator bottle. 3. Two drops of reagent As1 is added to the sample and mixed well by gentle shake. 4. One level of blue spoon of reagent As2 is added to the solution and mixed well to dissolve it. 5. One level of yellow spoon of reagent As3 is added and the lid of the bottle is closed quickly. 6. The generator bottle is now left for 20 minutes and during this period the bottle is shaken 2-3 times. 7. The strip is then removed and dipped quickly in distilled water. Excess of water is removed by simply shaking and the colour is matched with standard Arsenic colour chart to find Arsenic concentration.

Fluoride **Reagents** 1. Zirconyl Alizarine	**Procedure** 1. 50 ml of water is transferred to graduated cylinder. 2. Transfer Zirconyl Alizarine till 52.5 ml mark in the cylinder. 3. The solution is mixed by pouring in the another cylinder. 4. The solution is allowed to developed colour for an hour. 5. The colour that is developed is compared with the colour comparison chart looking from the top of cylinder.

Chloride **Reagents** 1.Potassium chromate 2.Silver nitrate	**Procedure** 1. 5ml of water sample is transferred to a test tube. 2. 1 drop of potassium chromate is added to the sample. 3. 1 ml of silver nitrate solution is taken in 1 ml syringe and to titrate the solution till permanent brick red colour appears. Chloride = (Volume of silver nitrate consumed x 354.5) mg/l

Nitrate **Reagents** 1. Nitrate- A 2. Nitrate- B	**Procedure** 1. One spoon of reagent A is added in the water sample and the solution is shaked to dissolved the reagent. 2. One spoon of reagent B is added using another spoon and the solution is shaked to dissolved the reagent. 3. The colour that is developed in the solution is compared with the standard iron colour chart horizontally after 10 minutes of addition of reagent B.

Statistical analysis

The data were analyzed by statistical techniques like descriptive statistics, analysis of variance and Duncan multiple range post-hoc test using SAS enterprise guide 4.3 version.

Results and Discussions

pH

The average pH value (Table 1) of all the samples in the present study are found to be within the WHO (2011) [4] permissible limit but the values differed among the districts which may be due to variation in the soil composition and rock bed, release of industrial waste, composition of organic matter, etc.

TDS

The average TDS value (p>0.05) of all the samples in the present study are found to be within the WHO (2011) [4] permissible limit but the values differed among the districts which may be due to ground water pollution when waste waters from both residential and dyeing units are discharged into pits, ponds and lagoons enabling the waste migrate down to the water table.

Total hardness

The average total hardness (mg/l) obtained in the present study are shown in Table 1. Moreover, no significant (p>0.05) differences between the organized and unorganized farms were recorded in the study. The results of the present study are in agreement with Chetia *et al.*, (2011) [7].

The total hardness of drinking water may be due to high concentration of salt, proximity of industry which discharges its effluent into the water body, geographical location, weathering of limestone, sedimental rock, effluent or excessive application of lime to soil in agricultural areas etc.

Table 1: Average (Mean ± SE) pH, TDS and Total Hardness content of water samples of organized and unorganized sectors in different districts

Sector / Districts	Organized			Unorganized			p-value		
	pH	TDS	Total hardness	pH	TDS	Total hardness	pH	TDS	Total hardness
Dibrugarh	7.24±0.01	88.33 ± 6.00	78.67 ± 4.80	7.26±0.08	88.33 ± 3.07	73.33 ± 3.81	0.559	1.000	0.405
Kamrup (R)	7.24±0.02	93.33 ± 5.57	78.67 ± 4.80	7.16±0.04	93.33 ± 4.21	78.67 ± 6.33	0.156	1.000	1.000
Karbi Anglong	7.18±0.08	85.00 ± 4.28	76.00 ± 3.42	7.13±0.05	95.00 ± 5.62	88.00 ± 11.31	0.629	0.188	0.334
Nagaon	7.00±0.10	93.33 ± 4.94	74.67 ± 3.37	6.86±0.03	90.00 ± 5.77	81.33 ± 6.97	0.247	0.670	0.410
Sonitpur	7.21±0.05	88.33 ± 6.00	85.33 ± 8.92	7.28±0.03	86.66 ± 7.14	77.33 ± 4.46	0.310	0.862	0.441

Iron

The average iron (mg/l) content of water samples in the present study are shown in Table 2. Moreover, no significant (*p*>0.05) difference has been recorded between the organized and unorganized farms in the study. The values reported in the study is lower than the result reported by Chetia *et al.* (2011) [7] which may be attributed to differences in geographical location, hydro geochemistry, composition of soil, types of rock, leaching from nearby surface industrialization.

Sulfate

The average sulfate (mg/l) observed in the present study are recorded in Table 2. Moreover, no significant (*p*>0.05) differences between the organized and unorganized farms were recorded in the study. The results in the present study are in agreement with Chetia *et al.* (2011) [7]. However the result of the present study is lower than the result recorded by Das *et al.* (2003).

The differences in the results of sulfate of drinking water from the earlier workers may be due to decomposition of organic matter, fertilizers, combustion of fossil fuel that is oxidized and comes to ground through atmospheric fall out, hydro geochemistry, composition of minerals in the rock bed.

Arsenic

The average arsenic (mg/l) content of the water samples obtained in the present study are shown in Table 2. Moreover, no significant (*p*>0.05) differences between the organized and unorganized farms were recorded in the study. These results are in agreement with Kar *et al*. (2010) [3] whereas higher results were obtained by Sailo & Mahanta (2014) [8], Singh (2004) [6]. Chetia *et al.* (2011) [7] reported lower level of arsenic content as compared to the present study.

The differences in the results of Arsenic of drinking water with the earlier workers may be due to variation in the concentration of the minerals in the soil, variation in the hydrogeo chemistry, leaching of the mineral from surrounding rock bed, industrialization and other anthropogenic activities.

Table 2: Average (Mean ± SE) Iron, Sulfate, Arsenic, Fluoride, Chloride and Nitrate content of water samples of organized and unorganized sectors in different districts

Parameter	Sectors	Districts				
		Dibrugarh	Kamrup (R)	Karbi Anglong	Nagaon	Sonitpur
Iron	Organised	0.45 ± 0.05	0.90 ± 0.06	0.33 ± 0.04	0.95 ± 0.05	0.56 ± 0.08
	Unorganized	0.33 ± 0.04	0.85 ± 0.06	0.41 ± 0.06	0.90 ± 0.06	0.65 ± 0.05
	p- value	0.105	0.599	0.309	0.549	0.43
Sulfate	Organised	58.33±8.33	75.00±11.18	58.33±8.33	75.00±11.18	50.00±0.00
	Unorganized	66.67±10.54	58.33±8.33	66.67±10.54	66.67±10.54	58.33±8.33
	p- value	0.549^NS	0.260 ^NS	0.549 ^NS	0.599 ^NS	0.341 ^NS
Arsenic	Organised	0.003 ± 0.002	0.004 ± 0.002	0.007 ± 0.002	0.010 ± 0.007	0.009 ± 0.002
	Unorganized	0.004 ± 0.002	0.005 ± 0.002	0.008 ± 0.002	0.011 ± 0.006	0.010 ± 0.007
	p- value	0.549	0.188	0.599	0.843	0.605
Fluoride	Organised	0.61±0.01	1.15±0.03	0.28±0.01	0.47±0.02	0.50±0.02
	Unorganized	0.60±0.00	1.22±0.03	0.24±0.03	0.42±0.03	0.44±0.02

	p- value	0.504	0.183	0.334	0.236	0.126
Chloride	Organised	19.61±1.04	18.78±1.11	18.90±1.49	17.24±1.32	22.45±1.18
	Unorganized	21.46±1.52	20.08±2.17	18.78±1.11	17.95±1.04	19.61±1.04
	p- value	0.339	0.605	0.947	0.687	0.102
Nitrate	Organised	1.75±0.33	1.25±0.25	0.75±0.40	0.66±0.21	2.00±0.31
	Unorganized	1.50±0.31	1.50±0.31	0.91±0.37	0.83±0.16	1.75±0.33
	p- value	0.599	0.549	0.768	0.549	0.599

Fluoride

The average fluoride (mg/l) level obtained in the present study are mentioned in Table 2. Moreover, no significant differences have been found between the organized and unorganized farms in the study. The results of the present study are in agreement with Das *et al*. (2003) [11], Kar *et al*. (2010) [3].

The differences in the results of Fluoride of drinking water from the previous workers may be due to presence of different industries around the study area, geological variation, wide scale use of fertilizers and pesticides in the agricultural fields.

Chloride

The average chloride (mg/l) content recorded in the present study Table 2. However, no significant (p>0.05) differences between the organized and unorganized farms were recorded in the study. The results of the present study are in agreement with Choudhury *et al.* (2016) [10] while found to be higher than Kar *et al.* (2010) [3].

The differences in the chloride content of drinking water compared to the earlier workers may be due to natural processes such as the passage of water through natural salt formations in the earth, sewage, irrigation drainage, effluent from chemical industries, agricultural runoffs, refused leachates.

Nitrate

The average nitrate (mg/l) content of the water sample observed in the present study are shown in Table 2. However, no significant (p>0.05) differences between the organized and unorganized farms were recorded in the study. Higher nitrate content compared to the present study was recorded Das *et al*. (2003) [11].

The differences in the results of nitrate of drinking water from the previous workers may be due to geographical distribution, anthropogenic activities, indiscriminate use of chemical fertilizer and medicines for pest control, faulty sewage disposal.

Conclusion

From the result of the present study it may be concluded that the water offered to the livestock of organized and unorganized farms of the selected districts were below/within the permissible limit of WHO (2011) [4] except the iron which was above the guideline limit. Hence, necessary measures may be taken to reduce the iron (Fe) content of the water to the IS 10500, 2004 limit. However, further study may be required with a large number of samples to correlate the findings of present study.

Conflict of Interest: There is no conflict of interest among authors for this study.

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