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Effect of poultry dropping on water quality and fish growth parameters of Indian major carp in the foothill ponds of Arunachal Pradesh, India

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Abstract
The present experiment was designed to investigate the effect of poultry droppings on the water quality and growth parameters of Indian major carp during April 2012 to May 2013. Three ponds were selected each having an area of 1000m^2. Control (T_0) pond did not receive any additive while treatment 1 (T_1), treatment 2 (T_2) and treatment 3 (T_3) were manured with poultry dropping. Water temperature, pH, dissolved oxygen, specific conductivity, alkalinity, total hardness, turbidity and total dissolved solids were ranged 15.4 -29.6 ^{0}C and 15.4 - 29.7 ^{0}C, 6.1-7.6 and 6.2-7.4, 6.5-9.8 mg/l and 6.8- 9.7 mg/l, 0.203-0.569 µS/cm and 0.286-0.584 µS/cm, 62-114 mg/l and 89-121 mg/l, 62-138 mg/l and 91-134 mg/l, 15.83-6.68NTU and 23.41-52.21NTU, 68-264 mg/l and 168-287 mg/l in the treatments and control pond respectively. The net production and fish growth in the treatment ponds was maximum in comparison to control pond. The significantly (p<0.05) highest net production of fishes was recorded in T_2 (3853.20 kg/ha/yr) in comparison to T_0 (1227.69 kg/ha/yr). The percentage increase of fish production in T_1, T_2 and T_3were 56%, 68% and 53% respectively as compared to T_0. The favourable water quality and net production of fish in T_2 comparison to T_1, T_3 and T_0 affirmed that the droppings of 90 numbers of poultry birds was the standard dose for integrated fish poultry farming in foothills of Arunachal Pradesh.

Keywords: Fish growth, Indian major carp, Poultry dropping, Water quality parameters.

1. Introduction
The poultry dropping is one of the best organic manure due to its adequate amount of major nutrients (N, P and K) and trace elements (Vohra *et al*., 2012)[1]. The applied manures enhances necessary soil nutrient which serves as soil fertilizer and promotes biomass of planktonic and benthic organisms (Atay and Demir, 1998; Sloan *et al*., 2003) [2, 3]. Poultry dropping is preferred among all the commonly used manure because of its solubility and high level of phosphorus content (Knud- Hansen *et al*., 1991) [4]. Moreover, integrated fish-poultry farming system is the best option for low cost fish production (Bhatnagar and Devi, 2013; Oladosu *et al*., 1990) [5, 6]. Javed *et al.* (1990) [7] reported a fish yield of 5955.83kg/ha/year by using poultry manure. Application of high amount poultry dropping reduce water quality, deplete the plankton population and cause adverse impact on the growth of the Indian Major Carp (IMC) (Vohra *et al*., 2012)[1]. Indiscriminate use of poultry dropping as pond manure may avert many such problems like eutrophication, algal bloom and fish mortality (Dhawan and Toor, 1989) [8]. Therefore it is necessary to standardised the dose of poultry manures that will help to improve water quality of fish pond for scientific fish culture. There is scanty of information on the use of poultry dropping for optimum production of zooplankton and phytoplankton in grow out ponds (Vohra *et al*., 2012) [1]. The present study was carried out to investigate the effect of poultry dropping (manure) on various water quality parameters of the pond and growth performance of IMC to recommend the suitable numbers of poultry birds for maximum fish production in the foothills without deteriorating the water quality status of the fish pond.

2. Materials and methods
2.1 Experimental protocol and set-up
The study was conducted in four earthen ponds viz. T_0,T_1, T_2 and T_3 pond at Midpu (altitude: 148 msl) village, Papumpare district. The 2.5 meter water depth was maintained in all the ponds having an area of 1000m^2. All the pre-existing ponds were made ready by draining water and sun dried for fifteen days before beginning of the trials. The dried bed of the ponds was ploughed properly and applied lime @250kg/ha. The ponds were filled with ground as well as rain water up to a depth of 2.5 meters. Poultry sheds having an area of 105, 135 and 165 square feet were built over T_1, T_2 and T_3 ponds respectively, using locally available materials, such as woods, thatch of straw and bamboo. The floor was made of split bamboo with a gap of about 1.0 cm between slats, which facilitated the poultry dropping to fall directly into the culture pond. The poultry shed were built on the northern side of the pond to avoid the shading over the pond. The apex height of

the house from the floor was 3.6m and the height of the walls was 2.72m. The floor of the shed was 1.5m above the pond water level. This made a special precaution to allow sunlight for proper growth of primary producers. We have selected the Vencob white broiler breed based on the local poultry farmer's information on its high growth rate (1.6 to 1.8kg/45 days approx.) and readily availability of one-day old chicks for immediate use. The average weight of day old chicks was 38.5g. The six batches of 70, 90 and 110 numbers of broiler chicks was reared in poultry sheds of T_1, T_2 and T_3 ponds respectively, for providing a continuous supply of poultry droppings to the culture ponds during the experiment period. No supplementary feed and fertilizer were applied in T_0 as well as in the experimental ponds (i.e. T_1, T_2 and T_3) during the period of study. Fish fingerling procured from State Government fish hatchery, Emchi, Arunachal Pradesh. The fingerlings were acclimatized in a Happa of size 10×5×3 ft^3 which was fixed at the same stocking pond for three days, then stocked only those healthy fingerlings in respective ponds @ Catla (*Catla catla*) 3: Rohu (*Labeo rohita*) 3:Mrigal (*Cirrhinus mrigala*) 4 maintaining stocking density of 10,000 fingering/ha. The initial average weight of the fingerlings of Catla, Rohu and Mrigal were 4.8g, 6.2g and 7.4g respectively.

2.2 Monitoring of physico-chemical parameters of water

Monthly variation of water temperature, pH, dissolved oxygen, specific conductivity, alkalinity, total hardness, total dissolved solids and turbidity were analysed (APHA, 2005) [9].

2.3 Sampling of plankton

The plankton samples were collected by filtering 50 litres of water through a plankton net (mesh size 60µm). The filtrate was collected in the vial for further quantitative analysis following drop count method (Lackey, 1938) [10].

2.4 Fish growth parameters

Various fish growth parameters like average final weight gain, growth rate, survival rate and production were recorded monthly. The following parameters and formulas were used to evaluate the growth performances and final yield of fish.

For fish

Length gain (cm) = Average final length - Average initial length

Weight gain (g) = Mean final weight - Mean initial weight

Specific growth rate (SGR) = (final weight - initial weight)/Culture period in days

Survival rate (%) = Number of fish harvested × 100/ Number of fish stocked

Yield kg/ha/yr = biomass at harvest - biomass at stock

For the computation of the data, ANOVA test was applied as suggested by Steel and Torrie (1981) [11].

3. Results

3.1 Effect of poultry dropping on physico-chemical parameters of water

Water temperature, pH, dissolved oxygen, specific conductivity, alkalinity, total hardness, total dissolved solids and turbidity were recorded at monthly interval. The range and mean values of the all physico-chemical parameters in different treatments and control pond were presented in Table1.

Table 1: Variation in water quality in experimental ponds.

Parameters	T_0		T_1		T_2		T_3	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Water temperature. (^{0}C)	15.6- 29.5	23.96±5.86	15.5-29.4	23.76±5.42	15.4- 29.6	23.84±5.84	15.4-29.7	23.86±5.74
pH	6.2-7.2	6.6±0.35	6.5-7.6	6.8±0.38	6.1-7.3	6.4±0.36	6.2-7.4	6.5±0.39
Dissolved oxygen (mg/l)	6.5-9.5	7.6±0.88	6.7-9.5	7.8±0.85	7.2-9.8	7.7±0.87	6.8- 9.7	6.8±0.86
Specific conductivity (µS/cm)	0.230-0.509	0.389±0.09	0.203-0.486	0.414±0.11	0.274-0.569	0.432±0.16	0.286-0.584	0.534±0.21
Alkalinity (mg/l)	62-94	81.8±11.0	68-96	82.5±11.5	87-114	84.4±14.1	89-121	87.3±18.4
Total hardness (mg/l)	62-114	96.2±13.42	67-112	95.5±11.82	94-138	98.2±14.7	91-134	97.1±13.11
Turbidity (NTU)	15.83-25.11	21.20±3.62	16.44-26.32	21.54±3.72	21.48-46.68	24.52± 4.21	23.41-52.21	25.36±4.86
Total dissolved solid (mg/l)	68-192	172.2±16.54	72-196	174.3±17.21	158-264	209.4±22.42	168-287	211.4± 24.85

The maximum water temperature recorded in T_0, T_1, T_2 and T_3 were 29.5 ^{0}C, 29.4 ^{0}C, 29.6^{0}C and 29.7 ^{0}C during April while minimum temperature recorded in T_0, T_1, T_2 and T_3 were 15.6 ^{0}C, 15.5 ^{0}C and 15.4 ^{0}C and 15.4 ^{0}C during January. In T_1 (7.4), T_2 (7.7) and T_3 (7.4) higher values of pH were noted in October while in T_0(7.2) in April; however, the lowest was observed in T_1 (6.5), T_3 (6.2)and T_0 (6.2) in August and T_2 (6.1) in January. The dissolved oxygen was maximumin January in all the ponds (T_0-9.5mg/l, T_1-9.5mg/l, T_2-9.8mg/l and T_3-9.7mg/l) but minimum in May (T_1-6.7mg/l and T_0-6.5mg/l) while T_2 (7.1mg/l) and T_3(6.8 mg/l) during June. The alkalinity was maximum in May (T_0-94mg/l, T_1-96mg/l, T_2-87mg/l and T_3-89mg/l) and the minimum T_1 (68 mg/l), T_2 (87mg/l) and T_3 (89mg/l) during February, though T_0 (62mg/l) showed its minimum in December. Total hardness higher in September (T_0-114mg/l, T_1-112mg/l, T_2-138mg/l and T_3 (134mg/l)) in all ponds, but lower value in January (T_0-62mg/l, T_1-67mg/l, T_2-94mg/l and T_3-91mg/l). Turbidity was observed higher in April (T_0-25.11NTU, T_1-26.32NTU, T_2-46.68NTU and T_3-52.21NTU) and low in January in T_0 (15.83 NTU), T_2 (21.48 NTU) and T_3 (23.41NTU) while T_1 in October (16.44NTU). The maximum value of conductivity in T_0 and T_1 were 0.509µS/cm and 0.486µS/cm in August while in T_2 and T_3 was 0.569µS/cm and 0.584µS/cm in July. The low conductivity value in T_0, T_2 and T_3 were 0.230µS/cm, 0.274µS/cm and 0.286µS/cm in March but in T_1 was 0.203µS/cm in December. Total dissolved solids recorded peak inT_0 (192mg/l), T_1 (196mg/l), T_2 (264mg/l) and T_3 (287mg/l) in December. The lowest values were T_0 (88mg/l), T_1(72 mg/l),T_2(158 mg/l) and T_3(168mg/l)

3.2 Effect of poultry dropping on growth performance of fishes

The growth performance of Catla, Rohu and Mrigal in terms of average initial weight (g), average final weight (g), average net weight gain (g), growth rate (g/day), Survival (%), total production (kg/ha/yr) and net production (kg/ha/yr) are shown in table 2. The significantly (p<0.05) highest average net weight gain by Catla, Rohu and Mrigal were 240.18g, 173.64g and 141.18g, 574.73g, 420.02g and 291.13g, 688.74g, 545.70g and 414.62g, 746.84g, 640.74g and 475.08g in T_0,T_1,T_2 and T_3 respectively. The percentages of survival were highest in T_2 followed by T_1, T_0 and T_3. The production of Catla, Rohu and Mrigal were recorded in T_2 (1498.35g, 1392.82g and 962.02g) followed by T_3 (927.08g, 1021.42g and 683.28g), T_1 (1220.60g, 982.21gand 612.03g) and T_0 (534.78g, 391.13g and 301.78g) respectively. The significantly (p<0.05) highest net production of fishes was noticed in T_2 (3853.20 kg/ha/yr) in comparison to T_0 (1227.69 kg/ha/yr). The percentage increase in fish production in T_1, T_2 and T_3 were 56%, 68% and 53% respectively as compared to T_0.The peak level of plankton productions were 462 numbers/l, 682 numbers/l, 774 numbers/l and 562 numbers/l in July while low density of plankton were 269 numbers/l, 392 numbers/l, 588 numbers/l and 304 numbers/l in January in the T_0, T_1, T_2 and T_3 respectively.

Table2: Growth performance of three Indian Major Carps in T_0, T_1, T_2 and T_3 ponds

Ponds	Fish species	Average initial weight (g)	Average final weight (g)	Average net weight gain (g)	Growth rate (g/day)	Survival (%)	Production of individual species (kg/ha/yr)	Net production (kg/ha/yr)
T_0	Catla	5.4	245.58	240.18	0.66	74.0	534.78	1227.69
	Rohu	6.2	179.84	173.64	0.47	76.0	391.13	
	Mrigal	7.8	148.98	141.18	0.39	53.0	301.78	
T_1	Catla	5.2	579.93	574.73	1.57	71.0	1220.60	2814.84
	Rohu	6.1	426.12	420.02	1.15	78.0	982.21	
	Mrigal	7.8	298.93	291.13	0.80	52.4	612.03	
T_2	Catla	5.5	694.24	688.74	1.89	72.4	1498.35	3853.20
	Rohu	6.4	552.10	545.70	1.50	84.8	1392.82	
	Mrigal	7.5	422.12	414.62	1.14	57.8	962.02	
T_3	Catla	5.4	752.24	746.84	2.05	41.3	927.08	2631.78
	Rohu	6.1	646.84	640.74	1.76	53.0	1021.42	
	Mrigal	7.6	482.68	475.08	1.30	36.0	683.28	

Table 3: Plankton density of the ponds

Ponds	T_0	T_1	T_2	T_3
High plankton density (numbers/l)	462	682	774	562
Low plankton density (numbers/l)	269	392	588	304

4. Discussion

Physico-chemical parameters of water play a vital role in the biology and physiology of fish (Vohra *et al*., 2012) [1]. The water qualities in all experimental ponds were found to be within the suitable ranges except T_3 which matched with the observation of Jhingran (1991) [12]. The biological productivity of any aquatic body is generally judged through the qualitative and quantitative estimation of plankton, which form the natural food of fish (Ahmed and Singh, 1989) [13]. The total planktonic growth showed significantly (p<0.05) higher in the treated pond as compared to control may be due to high levels of water-soluble phosphates in the poultry dropping also cohere with the observations of Vohra *et al*. (2012)[1]. There was autochthonous production of plankton in all treatment ponds. High amount of poultry dropping in T_3 significantly (p<0.05) increased the pH, alkalinity, hardness, conductivity, turbidity and total dissolved solid probably considered as the indication of environmental stress ultimately declining the net production of fishes. These findings were in corroborating with the observation of Jana and Chakrabarti (1993) [14]. The relative abundance of plankton may contribute to the different growth of the Catla, Rohu and Mrigal. Lower weight gain, specific growth rate and survival in the control pond may be attributed to the insufficient quantity of zooplanktons and phytoplankton in the system (Szlaminska and Przybye, 1986) [15]. Moreover, it was also revealed that relatively higher density of plankton in T_2 as compared to T_0, T1 and T_3. This could be a consequence of relatively suitable environment in terms of water quality and food abundance (Jana and Chakrabarti, 1993) [14]. The application of manure enhances plankton productivity however; after a certain limit may be a cause for detoriation of water quality, plankton and fish growth. Plankton biomass decline due to undesirable water quality with very high amount of fertilizers (Lin *et al*., 1997; Garg and Bhatnagar, 1999; Azim *et al*., 2001; Cheikyula *et al*., 2001) [16, 17, 18, 19]. The net production of fishes were significantly low (p<0.05) in T_3 due to low survival rate compared to T_0, T_1 and T_2. The survival rate of fishes in T_3 decline because of eutrophication. The weight gain of Catla, Rohu and Mrigal in T_1 was low due to insufficient amount of plankton. In case of T_2 the optimum amount of plankton was present therefore; net production of fishes was higher. In the present investigation application of poultry dropping (90 numbers poultry/1000m^2 areas of the pond) appeared to be the most suitable for Catla, Rohu and Mrigal. High amount of application of poultry dropping reduce water quality, deplete the plankton population and cause adverse impact on the growth of the Indian Major Carp (IMC) (Vohra *et al*., 2012)[1]. The maximum net production of fishes was obtained in T_2 as compared to T_0, T_1 and T_3. This may be the effect of different amount of poultry dropping which release nutrients in the water body, ultimately increased in plankton density. The three fish species *Catla catla*, *Labeo rohita* and *Cirrhinous mrigala* gained significantly different length and weight under different levels of broilers manure fertilization (Javed *et al*., 1990; Hassan and Javed, 1999) [20., 21]. Maximum weight gain in treating pond was recorded during July, August, September,

October and November months due to optimum temperature while lowest weight gain was recorded during December, January and February due to low temperature. It was reported that low temperature (22.6 ^{0}C) decreased the activity and food intake, whereas the high temperature (up to 33 ^{0}C) had opposite effects (Wohlfarth, 1978) [22]. The water temperature was the most important variable which contributed significantly towards the fish yield increment (Khan *et al*., 1995) [23]. The best temperature, which had a positive and significant influence on increase in fish weight, was ranging from 29.32 to 32.95 ^{0}C (Ahmad, 1996) [24]. In the present investigation, higher fish production was recorded in T_1 (2814.84kg/ha/yr), T_2 (3853.20kg/ha/yr) and T_3 (2631.78kg/ha/yr) as compared to T_0 (1227.69kg/ha/yr). Higher fish production in T_1,T_2 and T_3 in comparison to T_0, due to effect of poultry dropping. This finding was similar to the observation of Abbas *et al*. (2004) [25]. It was reported that broiler dropping added in the pond has a significant effect on fish growth, which gave the better net fish yield of 3617.50 kg/ha/year (Hassan,1998) [26]. The growth performance of six species viz; *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Hypothalmichthys molithrix*, *Ctenopharyngodon idella* and *Cyprinus carpio* under the influence of artificial feed, broiler dropping, buffalo manure, N:P:K (25:25:0) and a control pond for a period of one year. Broiler manure and N:P:K (25:25:0) fertilization remained the best treatment for maximum fish production of 9400 kg/pond/year and 7300kg/pond/year, while the fish production of artificial feed, buffalo manure and control pond were 6200 kg/pond/year, 4400 kg/pond/year and 1500 kg/pond/year respectively (Mahboob and Sheri, 2002) [27]. Manuring of the pond with poultry dropping triggered significant increases in fish production compared to control pond. The percentage increase in fish production in T_1, T_2 and T_3 are 56%, 68% and 53% respectively as compared to T_0. It was recorded a daily growth rate of 2.75g, 2.36g and 2.18g respectively, for Catla, Rohu and Catla –Rohu hybrids employing cow dung and poultry manure in ponds (Keshavnath *et al*., 1980) [28]. The better growth rate for Indian major carps in poultry manure treated pond (1.93g, 1.66g and 1.2g per day for Catla, Rohu and Mrigal respectively) than in the gober gas slurry treated ponds (1.38g, 1.10g and 0.97g per day for Catla, Rohu and Mrigal respectively (Laha and Mitra, 1987) [29]. The population density of plankton in the T_1, T_2 and T_3 ponds were significantly (p<0.05) increased compared to T_0. The variation in plankton production might be due to varying amounts of poultry dropping loads in the T_1, T_2 and T_3 ponds. The plankton density varies in poultry dropping treated ponds in compared to traditional fish culture pond (Javed *et al*., 1990) [20]. The decomposition processes of poultry dropping in the integrated fish-poultry farming system gradually release N, P and K which triggers plankton productivity (Schrooder, 1980) [30]. The growth and survival of Indian Major Carp was different under different amount of poultry dropping. Higher survival was recorded in T_1 (with low dose) followed by T_2 and T_3. Survival of fish was decreased as increase the doses of poultry droppings. The high mortality was recorded in T_3. The results indicated that the growth rate of Catla, Rohu and Mrigal variations in different treatment. The net production of fishes T_2 showed better result followed by T_1, T_3 and T_0. High growth of different fish species with lower dose of poultry manure and lowest production in high dose of poultry manure (Chaitiamvong, 1977; Ahmed *et al*., 1983; Hoque *et al*., 1984; Azimuddin *et al*., 1999) [31, 32, 33, 34].

The water quality parameters were found to be suitable range in the present study. The temperature varies between 15.4 to 29.7 ºC during the study period. Water temperature greater than 18 ºC was best for survival and growth of warm water fishes and many species suffered and died below 12 ºC (Nagel, 1979) [35]. The water temperature ranged 24 ºC to 30 ºC was found suitable for raising carps in a pond environment (Santhosh and Singh, 2007) [36]. IMCs reduced physiological activity and food intake in lower temperature below 22.6 ºC whereas higher temperature (up to 33.0 ºC) had opposite effects (Biswas *et al*., 2010) [37]. It is known that water temperature ranging between 29.32 to 32.95 ºC is most suitable for the warm water fish culture (Villaluz and Unguui, 1983; Hassan and Javed, 1999) [38, 21]. The tropical fish growth rate is higher in temperature between 25 ºC and 32 ºC (Parker and Devis, 1981) [39]. The pH ranged from 6.1 to 7.6. The variation of pH in poultry dropping treated ponds was probably because of cumulative effects other biotic and abiotic factors, along with input of additional faecal droppings into water (Pillay, 1990) [40]. The pH ranging from 5.0 to 9.0 was found reasonably appropriate for carp farming as well as for biological productivity (Chakroff, 1976; Hepher and Burginin, 1981; Bhatnagar and Devi, 2013) [41, 42, 5]. The pH recorded from the experimental ponds was within the acceptable range and corroborated with the findings of Mahboob and Sheri (2002) [27]. Fish culture suited optimally in between 6.7 to 9.5 pH, above and below which it exerted stress to the fishes (Santhosh and Singh, 2007; Wurts and Durborow, 1992) [36, 43]. The dissolved oxygen values during the experimental period were found between 6.5 to 9.8 mg/l. The variation in DO concentration in aquatic bodies might be caused due to seasonal variation in temperature and fluctuations of photosynthetic and respiratory activities of the aquatic biomass (Chapman and Kimstach, 1992; Gogoi *et al*., 2015) [44, 45]. The range of dissolved oxygen in all the sites did not differ significantly, which were in concordance with Mahboob and Sheri (2002) [27]. The ideal range of DO level is 5 to 15mg/l and low dissolved concentration (2-4mg/l) fish cease to feed, reduce locomotion and use the available oxygen to support physiological system rather than growth (Parker and Devis, 1981; Ayinla *et al*., 1994; Ekubo and Abowei, 2011)[39, 46, 47]. In the present study conductivity varied from 0.203µS/cm to 0.584µS/cm which might be due to the high amount of poultry droppings. Rahman (1992) [48] has reported the similar observation. Alkalinity varies between 62-121mg/l. The fluctuation of alkalinity was more due to the effect of poultry dropping. The dispersed carbonate and bicarbonate ion made the pond water slightly alkaline in nature meeting the suitability for growth and survival of aquatic organism (Panday and Lal, 1995; El-Saidy and Gaber, 2003; Swelium *et al*., 2005) [49, 50, 51]. The ideal value of alkalinity is 50-300 mg/l for undertaking fish culture (Santhosh and Singh, 2007) [36]. The alkalinity values of all the treated ponds were within the desirable range. Total hardness fluctuated between 62-138 mg/l. The recommended water hardness of pond water for fish culture ranges between 20 mg/l to 180 mg/l (Santhosh and Singh, 2007; Ekubo and Abowei, 2011) [36, 47]. Uniformity of alkalinity and hardness further revealed that the dissolved nutrients were in balanced amount which provided a congenial water quality parameters and favourable environment for

plankton production. The findings of the present study were in conformity with Mahboob and Sheri (2002) [27]. The fluctuation of turbidity because of poultry dropping loading was more. So plankton level increased. Similar results were obtained by Hassan and Javed (1999) [21]. The total dissolved solid fluctuated between 68-287mg/l. It was found that total dissolved solid level variations due to poultry dropping and plankton density (Jhingaran, 1991; Vohra *et al*., 2012) [12, 1].

5. Conclusion

The application of poultry dropping as manure was found to be effective for integrated fish poultry farming system. However, effect of poultry dropping is related to the amounts of dropping receive by respective pond. The net fish productions were influenced by different doses of poultry dropping in all treated ponds which may be attributed to variability in water quality and extent of plankton production. Therefore, it can be concluded that 90 numbers of poultry birds dropping was standard doses as compared to 70 and 110 number of poultry birds dropping for favourable water quality and fish growth in foothills of Arunachal Pradesh.

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