Water in Livestock and Poultry Nutrition: A Review on Consumption and Quality

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Table S1. Indicative water requirements (liters per kg of dry matter intake) for cattle and sheep according to different physiological stages (adapted from McDonald et al. [16]).

Physiological Stage	**Water Requirements (Liters per kg Dry Matter Intake)**		
	Environmental temperature (°C)		
	< 16.0 °C	16.0 – 20.0 °C	> 20.0 °C
Cattle			
Calves up to the age of 6 weeks	7.0	8.0	9.0
Growing or adult, pregnant or non-pregnant cattle	5.4	6.1	7.0
Cows producing 10 L milk daily	81	92	105
Cows producing 20 L milk daily	92	104	119
Cows producing 30 L milk daily	103	116	133
Cows producing 40 L milk daily	113	128	147
Sheep			
Lambs up to the age of 4 weeks	4.0	5.0	6.0
Growing or adult, non-pregnant sheep	2.0	2.5	3.0
Twin-bearing ewes at mid-pregnancy	3.3	4.1	4.9
Twin-bearing ewes at mid-pregnancy	4.4	5.5	6.6
Lactating ewes (1st month post-lambing)	4.0	5.0	6.0
Lactating ewes (2nd-3rd month post-lambing)	3.0	3.7	4.5

Table S2. Indicative water requirements (liters per animal) for pigs according to different physiological stages (adapted from McDonald et al. [16]).

Physiological Stage	Water Requirements (Liters per Animal)
Growing piglets 15 kg bodyweight	1.5–2.0
Growing piglets 90 kg bodyweight	6.0
Non-pregnant sows	5.0
Pregnant sows	5.0–8.0
Lactating sows	15.0–20.0

Table S3. Daily water intake by dairy cattle (adapted from Adams and Sharpe [41]).

Cattle Type	Litres [1]
Holstein calves, age 1 month	4.9–7.6
Holstein calves, age 2 months	5.7–9.1
Holstein calves, age 3 months	8.0–10.6
Holstein calves, age 4 months	11.4–13.3
Holstein calves, age 5 months	14.4–17.5
Holstein heifers, age 15-18 months	22.5–27.0
Holstein heifers, age 18-24 months	27.6–36.5
Lactating cows	[2]
Dry cows, pregnant 6^{th} – 9^{th} month	34.1–49.2

[1] For ambient temperatures 10 °C to 27 °C, intake depends upon the water content of the forage consumed. Higher levels apply to an all-hay ration.

[2] Drinking water for lactating cows largely depends on production level, dry matter intake and ration water intake. It can be estimated using the following equation and procedures: (1) Drinking water intake (kg/day) = Total water intake (kg/day) – ration water intake (kg/day), (2) Total water intake (kg/day) = (4 × dry matter intake (kg)) + 4% FCM (kg/day) + 11.6, (3) 4% FCM (fat corrected milk, kg/day) = (0.4 × milk production (kg)) + 15 × (milk (kg) × % fat (decimal)), (4) Ration water intake (kg/day) = Total ration (kg/day) × % ration humidity.

Table S4. Indicative water requirements (liters per day) by beef cattle according to different environmental temperatures and physiological stages (adapted by NRC [29]).

Water Requirements (Liters per Day)						
Body weight (kg)	Environmental temperature [a] (°C)					
	4.4 °C	10.0 °C	14.4 °C	21.1 °C	26.6 °C	32.2 °C
Growing heifers, steers and bulls						
182	15.1	16.3	18.9	22.0	25.4	36.0
273	20.1	22.0	25.0	29.5	33.7	48.1
364	23.0	25.7	29.9	34.8	40.1	56.8
Finishing cattle						
273	22.7	24.6	28.0	32.9	37.9	54.1
364	27.6	29.9	34.4	40.5	46.6	65.9
454	32.9	35.6	40.9	47.7	54.9	78.0
Pregnant cows, during winter [b]						
409	25.4	27.3	31.4	36.7	-	-
500	22.7	24.6	28.0	32.9	-	-
Lactating cows						
>409	43.1	47.7	54.9	64.0	67.8	61.3
Mature bulls						
636	30.3	32.6	37.5	44.3	50.7	71.9
727	32.9	35.6	40.9	47.7	54.9	78.0

[a] Daily water intake of beef cattle is correlated with the dry matter intake and environmental temperature. Water intake is quite stable up to 4.4°C. [b] Dry matter intake has a major effect on water intake. Over-conditioned cows require less dry matter and, thus, less water intake.

Table S5. Daily water intake by sheep (Liters/kg dry matter intake) under average environmental temperature 15°C (adapted by Annicchiarico and Taibi [58]).

Sheep Type	**Water Requirements [a] (Liters per kg Dry Matter Intake)**
Growth or fattening	2.0
Maintenance or early pregnancy	2.0–2.5
Late pregnancy:	
One foetus	3.0–3.5
Two to three foetuses	3.5–4.5
Lactation period:	
first month (milk yield 2 L/day)	4.0–4.5
following months	3.0–3.5

[a] Water intake increased by 30, 50 and 100% for average environmental temperatures of 20, 25 and 30°C.

Table S6. Water intake (mL per animal per week) by chickens and turkeys of different ages (adapted by NRC [24]).

Age (weeks)	Broiler Chickens [a]	White Egg-Laying Hens [a]	Brown Egg-Laying Hens [a]	Large white turkeys [a,b]	
				Males	Females
1	225	200	200	385	385
2	480	300	400	750	690
3	725	-	-	1.135	930
4	1.000	500	700	1.650	1.274
5	1.250	-	-	2.240	1.750
6	1.500	700	800	2.870	2.150
7	1.750	-	-	3.460	2.640
8	2.000	800	900	4.020	3.180
9		-	-	4.670	3.900
10		900	1.000	5.345	4.400
11		-	-	5.850	4.620
12		1.000	1.100	6.220	4.660
13		-	-	6.480	4.680
14		1.100	1.100	6.680	4.700
15		-	-	6.800	4.720
16		1.200	1.200	6.920	4.740
17		-	-	6.960	4.760
18		1.300	1.300	7.000	-
19		-	-	7.020	-
20		1.600	1.500	7.040	-

Dash indicates unavailable information, [a] Water intake depends on environmental temperature, diet composition, growth rates, egg production and management system. Data presented apply under moderate (20° to 25°C) environmental temperatures, [b] Based on data obtained from commercial turkey farms.

Table S7. Microbiological parameters for water quality [24].

Parameter	Allowed Value (per 100 mL)
Escherichia coli	0
Enterococci	0

Table S8. Selected chemical parameters for water quality [24].

Chemical Substances	Allowed Value	Unit
Acrylamide	0.10	mg L^{-1}
Antimony	5.0	mg L^{-1}
Arsenic	10.0	mg L^{-1}
Benzene	1.0	mg L^{-1}
Benzo(a)pyrene	0.010	mg L^{-1}
Boron	1.0	mg L^{-1}
Bromate	10.0	mg L^{-1}
Cadmium	5.0	mg L^{-1}
Chromium	50.0	mg L^{-1}
Copper	2.0	mg L^{-1}
Cyanide	50.0	mg L^{-1}
1,2-dichloroethane	3.0	mg L^{-1}
Epichlorohydrin	0.10	mg L^{-1}
Fluoride	1.5	mg L^{-1}
Lead	10.0	mg L^{-1}
Mercury	1.0	mg L^{-1}
Nickel	20.0	mg L^{-1}
Nitrate	50.0	mg L^{-1}
Nitrite	0.50	mg L^{-1}
Pesticides	0.10	mg L^{-1}
Pesticides—Total	0.50	mg L^{-1}
Polycyclic aromatic hydrocarbons	0.10	mg L^{-1}
Selenium	10.0	mg L^{-1}
Tetrachloroethene and Trichloroethene	10.0	mg L^{-1}
Trihalomethanes—Total	100.0	mg L^{-1}
Vinyl chloride	0.50	mg L^{-1}

Table S9. European Legislation and Regulations

The European Commission has adopted an integrated legislative framework for food safety that covers the entire production chain, beginning at the level of primary animal production, in order to ensure safe, high-quality food for consumers [89-97]. Member States comply with this framework through national legislation governing animal management, welfare and production practices, including drinking water provision. Key legal instruments relevant to livestock water quality and use include the following.

1)	Regulation (EC) No 178/2002 of the European Parliament and of the Council [90], which establishes the general principles of food law and the European Food Safety Authority. Article 3 defines "feed" (or "feeding stuff") as any substance or product intended for oral feeding to animals. Under this definition, drinking water is considered a feed material within EU legislation [7,25].
2)	Regulation (EC) No 882/2004 on official controls to verify compliance with feed and food law, animal health and animal welfare rules [92]. This regulation recognises drinking water as a component addressed within specific feed and food legislation.
3)	Regulation (EC) No 852/2004 on the hygiene of foodstuffs [93]. This regulation defines potable water according to Directive 98/83/EC and requires food business operators to implement measures preventing contamination during primary production. Operators producing products of animal origin must use potable or clean water whenever necessary to prevent contamination.
4)	Regulation (EC) No 854/2004 laying down specific rules for official controls on products of animal origin intended for human consumption [91]. Audits of good hygiene practices include verification of water quality management.
5)	Regulation (EC) No 183/2005 on feed hygiene [94]. Farmers are required to minimise biological, chemical and physical contamination risks. Drinking water must be of appropriate quality for the species being produced, and watering equipment must be designed, maintained and cleaned to minimise contamination.
6)	Council Directive 98/83/EC on the quality of water intended for human consumption and Commission Directive (EU) 2015/1787, which amended its annexes [89,95]. These directives establish microbiological and chemical standards for potable water and include provisions for water used in food production, requiring it to be wholesome, clean and free from harmful microorganisms or substances at the point of use.
7)	Regulation (EU) 2017/625 of the European Parliament and of the Council on official controls and other official activities performed to ensure the application of food and feed law [96]. This regulation establishes a harmonised system of official controls across the agri-food chain, including primary production of livestock and poultry. It requires competent authorities to verify compliance with feed hygiene and animal welfare requirements, explicitly encompassing drinking water as a potential source of contamination. Controls include inspection, sampling and monitoring of water used on farms to ensure it does not compromise animal health or the safety of products of animal origin.
8)	Directive (EU) 2020/2184 of the European Parliament and of the Council on the quality of water intended for human consumption [97]. This directive introduces a risk-based approach to water quality management from source to point of use, with implications for water used in livestock and poultry systems. It establishes updated microbiological and chemical standards that serve as reference benchmarks for potable water used in animal production. Ensuring that drinking water provided to animals meets these standards supports the prevention of disease transmission, reduces contamination risks in the food chain, and contributes to overall animal welfare and productivity.