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Review Article

Review on Water Requirement and Utilization in Farm Animal

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Abstract

This paper aimed to review the role, requirements, utilization and water balance of livestock; dairy cows, sheep, beef cows, horses and chickens. Water is composed of two hydrogen atoms and one oxygen atom represented by H_2O. Water is the most essential nutrient, accounting for more than 50% and 75% of the body weight of old and young animals, respectively. It supports all vital functions of livestock digestion, transportation and absorption of nutrients and waste excretion, maintenance of blood volume and circulation, thermoregulation, reproduction, organ lubrication, different cell functions and chemical reactions/metabolism, electrolyte balance, growth and development, production. Water needs vary depending on such characteristics as species, sex, species, age, production level, and environmental conditions, diet composition, activity; livestock health conditions affect daily water requirements and utilization of farm Animal. Water quality is another important factor that affects livestock performance, as contaminants may affect metabolism, growth, reproduction, and water consumption. A good water management is essential to optimize animal health and productivity. Maintaining water balance is crucial to preventing physiological disorders. Animals obtain water from food, feed, and metabolic processes, and loss occurs through urine, excrement, milk, eggs, sweating, and breathing. Understanding the dynamics of water use can help improve the efficiency of livestock and sustainable livestock production systems.

Keywords

Farm Animal, Water, Water Requirement

1. Introduction

Water is one of the most important nutrients, consumed in larger quantity than other nutrients by livestock [23], and being the most abundant molecule in all living cells [27], is important nutrient needed for whole life and to optimize the milk production, growth rate and reproduction in livestock [13]. Water Serves as an essential solvent and plays a vital role in regulation of body temperature, lactation, digestion, elimination of waste products of digestion and metabolism, regulation of osmotic pressure, reproduction, [27, 29]. Water in dairy cattle is a critical nutrient and required for numerous essential physiological functions, the total body weight of dairy cattle is 56 to 81% water and water are the main component of milk and waste products [22]. In addition, this nutrient is especially important during periods of heat stress, for enhancing growth rates, and for improving resistance to diseases [6].

Water use or ingestion by the animal is related to different variables: body weight; dry matter intake; energy intake;

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effects of year seasons (temperature, radiation and humidity); restriction effect (drinking trough availability and spacing), water quality, species, breed and different physiological stages: growing, pregnancy and lactation [27]. Livestock and poultry fulfill their water needs by drinking, ingesting water contained in feed and minor amounts through metabolism (water produced by the oxidation of carbohydrate, fat, and protein). The entire of this water, primary avenues of loss are urinary excretion, fecal excretion, perspiration, and respiration [27]. Therefore, the main objective of this review is to examine the water requirements, utilization, role, sources of water gain, and way of water loss in farm animals.

2. Literature Review

2.1. Water Requirement in Farm Animal

In order to keep bodily fluids and proper ion balance, digest, absorb, and metabolize nutrients, remove waste and excess heat from the body, give the fetus a fluid environment, and transport nutrients to and from body tissues, water is essential [15]. The daily water requirement of livestock varies significantly among animal species. The animal's size and growth stage, consumption rates and feed type, air temperature, relative humidity, the level of animal exertion or production level, quality of the water (includes water temperature, salinity and impurities affecting taste and odors) that determine amount of water intake per day [13]. The water requirement of different species and even if within breed they have different water requirement under different Age and sex group, production level, environmental condition, feed type, health status, and water quality.

2.1.1. Dairy Cow Water Requirement

Water is the most important dietary component for dairy cattle, as insufficient water can limit milk production [26]. Lactating dairy cows require about 4 L of water for each kg of milk produced [16], which means if the cow produce 10 L of milk per day, 40 L of water is required per day. According to [15], the amount of water a cow will drink depends on her, size and milk yield, quantity of dry matter consumed, temperature and relative humidity of the environment, temperature of the water, quality and availability of the water, and amount of moisture in the feed. Water is an especially important nutrient during periods of heat stress. The high heat capacity of body water serves as insulation under cold stress, preserving body heat. The main elements influencing dry cows' free water intake are the diet's dry matter content, dry matter intake, and protein content.

Table 1. *Water requirements for various classes of dairy cattle.*

Class	Production Kg milk/day	Estimation of water consumption L/day
Holstien calves from 1-4 month	__	5-11
Holstien from 5-25 month	___	14-17
Dry cow (pregnant)	___	26-49
Jersey cows	13.6	49-59
Guernsey cows	13.6	52-61
Ayrshire, Brown Swiss and HF cows	13.6	55-64
	22.7	91-102
	36.3	144-159
	45.4	182-197

Source [16, 25].

Calves and Heifers under 25 months, during the liquid feeding stage, calves primarily obtain water from milk or milk replacer. However, providing additional water alongside a liquid diet promotes faster growth and encourages earlier dry feed consumption. Therefore, offering fresh water to calves on liquid diets is essential for improving growth rates and dry matter intake. Calves should be offered free-choice water along with calf starter by three days of age. Research has shown that depriving calves of fresh water decreases starter intake by 31% and weight gain by as much as 38% when compared to calves provided free-choice water [5]. As we can see from the table, as cows' milk production rises, so do their water requirements. Water should always be clean, fresh, and easily accessible, just as for any other livestock. To guarantee a sufficient and reliable water supply, caution must be exercised.

2.1.2. Sheep Water Requirement

The majority of the water that sheep need can be obtained by eating forage. Water intake rises in response to environmental temperature increases, along with weight and production level. A mature sheep needs 3.5 to 4.0 liters of water per day in the summer and 2 liters in the winter [36].

Table 2. Water intake for sheep in gallons per head per day.

Class	Weight (lbs)	Water Intake
Lambs	5-20	0.1-0.3
Feeder lambs	60-110	1-1.5
Pregnant ewes	175+	1-2
Lactating ewes	175+	2-3
Rams	175+	1-2

Source [21].

2.1.3. Chickens Water Requirement

Temperatures have a major influence on the water consumption rate expected from these other poultry classes. Egg production level will also affect the water consumption of laying hens. It is estimated that laying hens will drink about 4 kg of water per dozen eggs produced.

Table 3. Water intake by Laying hens, pullets, Broiler breeders per day.

Chicken Type	Weight Range (kg)	Water Requirement Range. A (L/1,000 birds/day)	Average Typical Water Use. B
Laying hens	1.6–1.9	180–320	250
Pullets	0.05–1.5	30–180	105
Broiler breeders	3.0–3.5	180–320	250

Source [3].

2.1.4. Beef Water Requirement

Beef cattle water requirements vary depending on the moisture content of feedstuffs, the stage of production, lactation, and environmental temperature (Table 4). While diet does affect daily water consumption, the main factors are temperature and humidity. Water requirements for beef cattle increase with animal weight, during pregnancy and lactation, and with elevated temperatures. Animals fed a diet with higher roughage content consume more water limiting water intake lowers feed consumption and animal performance.

Table 4. Daily water intake for beef cows based on temperature and level of production in gallons per head per day.

Growing Cattle				Finishing Cattle			Pregnant bull		Lactating cows	Mature Bull	
Temp.	400 lb	600 lb	800 lb	600 Ib	800 Ib	100 Ib	900 Ib	1100 ib	900Ib	1400 Ib	1600 Ib
40	4.0	5.3	6.3	6.0	7.3	8.7	6.7	6	11.4	8	8.7

Growing Cattle				Finishing Cattle			Pregnant bull		Lactating cows	Mature Bull	
Temp.	**400 lb**	**600 lb**	**800 lb**	**600 Ib**	**800 Ib**	**100 Ib**	**900 Ib**	**1100 ib**	**900Ib**	**1400 Ib**	**1600 Ib**
50	4.3	5.8	6.8	6.5	7.9	9.4	7.2	6.5	12.6	8.6	9.4
60	5.0	6.6	7.9	7.5	9.1	10.8	8.3	7.4	14.5	9.9	10.8
70	5.8	7.8	9.2	8.5	10.7	12.6	9.7	8.7	16.9	11.7	12.6
80	6.7	8.9	10.6	10.0	12.3	14.5	-	-	17.9	13.4	14.5
90	9.5	12.7	15.0	14.3	17.4	20.6	-	-	16.2	19	20.6

Source [28].

2.1.5. Horse Water Requirement

Horses typically consume 2-3 kg of water per kilogram of dry feed. They drink more in hot weather and while doing heavy work. Horse water intake is highly variable. Water intake is a based-on body weight, age, diet, exercise intensity and duration, lactation and temperature. In contrast to horses fed a more digestible grain diet, horses fed a fiber-rich forage-based diet need more water, and horses hot from exercise should have restricted access to water to avoid exertional rhabdomyolysis, laminitis, and colic [13].

Table 5. *Water requirement of horses based on the weight of horse.*

Frame Size (weight)	Water Requirement Range (L/day)	Average Water Use (L/day)
Small (500 lb)	13–20 16	16.5
Medium (1,000 lb)	26–39	32.5
Large (1,500 lb)	39–59	49

Source [13].

2.1.6. Swine Water Requirement

The housing method, growth stage and food strategy used affect the drinking water requirements of pigs. Other elements that influence swine water requirements include diet, temperature, housing and feeding techniques As dietary intake of salt and protein rises, so does water intake. Salt poisoning can occur in pigs fed a high-energy diet that are denied water but later given unrestricted access to it. Until they are completely rehydrated, they should only be given limited access to water [13].

Table 6. *Swine water consumption rate in different stage and level production.*

Swine type	Weight range (Kg)	Water requirement range (L/day)	Average typical water use (L/day)
Weaner	7-22	1-3.2	2
Feeder pig	23-26	3.2-4.5	4.5
	36-70	4.5-7.3	4.5
	70-110	7.2-10	9
Gestation sow/boar	-	13.6-17.2	15

Swine type	Weight range (Kg)	Water requirement range (L/day)	Average typical water use (L/day)
Lactating sow	-	18.1-22.7	20

Source [13].

2.2. Water Utilization in Farm Animal

2.2.1. Water for Egg and Milk Production

The amount of water expelled from the body will rise in tandem with an increase in productivity, given that milk and eggs, two of the most fundamental animal meals, contain 80–90% water. Animals will typically consume more water to maintain a steady quantity of water in their bodies, which is necessary for essential bodily functioning [17].

Compared to dry cows, farm animals that are nursing need more water. Both drinking water and feed moisture contribute to a dairy cow's daily water intake. Its demands are met by 25–35% of feed and 60–80% by drinking water. A lactating cow drinks 30 to 50 liters of water a day, if it is available [7]. A 90 kg gestating dairy ewe needs 4.4–7.1 L of water daily, with an average of 5.75 L per day, according to [13]. Water requirements, however, rise dramatically during lactation, with an average typical use of 10.4 L/day and a requirement ranging from 9.4 to 11.4 L/day.

2.2.2. Water for Metabolism

In farm animals, water serves as a medium for activities like digestion, absorption, metabolism, perspiration secretion, and facial and urine excretion. Water facilitates the passage of food through the gastrointestinal system and serves as a medium for the transit of hormones, waste products, nutrients, and other chemical messengers. Water is a key component of secretions like milk and saliva and aids in controlling blood osmotic pressure [13]. Animals' basic metabolism is endangered when they are dehydrated, which has a major impact on how well their major organs work. Often overlooked, water is essential for the health and well-being of animals [19].

2.2.3. Water for Thermoregulation

Water is essential for thermoregulation, which helps both humans and animals keep their body temperatures steady. For livestock and dairy animals in particular, this function is crucial since appropriate temperature control impacts their general well-being, production, and health. In order for animals to maintain a constant body temperature by evaporative cooling (sweating, panting), heat dissipation through respiration, blood circulation, and digesting, water is necessary for thermoregulation. Temperature changes are mitigated by its high specific heat capacity, but water loss from urine and feces also contributes. Animals react to temperature changes by changing their behavior and water intake. Ensuring constant access to clean water, especially in hot climates, helps prevent heat stress and supports overall health and productivity. Water plays significant role to maintain body temperature of Animal by providing thermoregulation and creates an environment for biochemical events in the body [17].

2.3. Source of Water for Animal

As [24], states that water requirement approximates free water intake plus water intake from feed and asserts further that the contribution of metabolic water to the requirement is minimal. However, animal receives its water from three sources, drinking water, feed water, and metabolic water [33]. Depending on the moisture content, the amount of water in the feeds that are ingested varies greatly from one feed to another. In dry feeds, it can be as low as 5%, while in succulent feeds, it can reach 90% or higher [32]. While water from succulent feeds can meet all of the water needs, water from dry feeds may be little when compared to the overall amount consumed. When the feed's water concentration exceeds 70%, sheep will drink little to no water [10, 32]. Drinking water is the primary source of water intake when the amount of water in the feed consumed is low, and providing it to the cattle becomes the primary concern.

Metabolic water is created from the hydrogen that is present when organic substances are oxidized during bodily metabolic processes. According to [20], on average, proteins, lipids, and carbohydrates produce 1.07, 0.56, and 0.40 milliliters of water per gram of oxidized matter, or 0.12, 0.14, and 0.10 milliliters of water per kcal of oxidized metabolized energy, respectively. Metabolic water makes up only 5–10% of the water consumption for the majority of domestic animals. Sheep may use up to 15% of their entire water intake as metabolic water [4, 1, 32], and this amount remains constant as long as their metabolic rate remains constant [20]. In certain circumstances, the production of metabolic water becomes more important because tissue protein and depot fat are catabolized to supply energy, particularly in animals that are eating less than is required.

2.4. Factor Affecting Water Consumption

Water consumption in animals is influenced by environmental factors (temperature, humidity, season), animal factors (species, size, lactation, pregnancy, activity), dietary factors (feed type, salt/mineral content, feed intake), water quality & availability (cleanliness, temperature, accessibil-

ity), and health status (disease, stress). Ensuring clean, easily accessible water helps maintain optimal intake and prevents dehydration. Water consumption is essential for animals, and several factors influence their daily water intake. Key factors include temperature, animal species, age, production level, productivity, and nutritional aspects that impact water requirements [17]. Poor quality water animal does not accept easily, it results in less water and feed intake, and poor feed conversion ratio ultimately decreased growth and production, poor performance and non-specific disease conditions [12].

2.4.1. Dry Matter Intake and Feed Type

The water content of the animal's diet will influence its drinking habits. Feed with relatively high moisture content decreases the quantity of drinking water required. In swine use of wet/dry feeders and liquid feeding systems has reduced the volume of drinking water required because of the higher moisture content in the feed ration and the reduction in spillage of water from these systems [37]. Feed consumption, as the consumed feed moves through the digestive system and creates an environment for easy digestion. Since ruminants secrete a lot of saliva during feed consumption, their water consumption is higher than Mono-gastric Animals [17]. According to [9] reported that lactating goats fed diet containing higher levels of in natural forage cactus in replacement with corn starch presented lower water ingestion with no effects on milk production. Similarly, [8] observed a decrease in water intake directly from drinking troughs as replacing forage cactus with elephant grass hay increased in sheep diet. Sheep fed diets with elephant grass hay as roughage drank 3.25 L/day while those fed diet containing forage cactus replacing elephant grass up to 56% of DM drank 0.44 L/day.

2.4.2. Feed Energy Sources and Protein Level

Salah States that daily drinking water requirements are influenced by the energy source and protein content of the feed [30]. Diets that include starch as a primary energy source result in higher water consumption compared to diets that include large amounts of fat to provide energy. Additionally, when the protein content of the feed increases, the animal requires more water to eliminate excess nitrogen from the body through urine in the form of urea dissolved in water. This process is more visible in mammals, but in other species such as birds, the principal product of protein breakdown is uric acid, which is eliminated from the body in a solid state without the need for additional water for the purpose of dissolving.

2.4.3. Temperature

The most important factor affecting water consumption is environmental temperature. [2] said that, feed intake decreases and water drinking increases at high environment temperatures, because more water is drunk because the heat is dissipated by breathing. According to [17], as environmental temperature rises, animals increase water intake to regulate body heat through sweating, respiration, or urine. Poultry, lacking sweat glands, are highly sensitive to heat stress, relying on increased water consumption and rapid breathing to dissipate excess heat. Their thermos neutral zone is 14-25 ℃, with higher temperatures raising their body temperature above 41 ℃. During hot weather and if cows are heat-stressed, they may drink double of water to that of the normal water requirement [35]. According to the [26], When cows are under heat stress, their water consumption increases to replenish the water lost through sweat, excrement, milk, and respiratory evaporation, which can increase water losses from sweating and respiration by 50 to 59 percent.

2.4.4. Age

Age-related changes in an animal's water needs can occur for the same species, primarily because of the body's water content. For the reasons previously described, the low rate of water consumption during that time naturally follows the high water content in the newborn's body, which gradually decreases with age due to changes in metabolic processes and increased body fat deposition [30].

2.5. Water Loss

Water is vital for sustaining homeostasis and physiological process in cattle. Nonetheless, water is constantly lost through a variety of processes, such as perspiration, evaporation from body surfaces and the respiratory system, urine, feces, and lactation. Effective livestock management and the avoidance of dehydration depend on an understanding of these losses and the variables that affect them. Water is lost through sweating, evaporation from body surfaces, and the respiratory system. It also happens through urine, faces, and milk. Cattle's activity level, air temperature, humidity, respiration rate, water intake, feed consumption, milk production, and other factors all affect how much water is lost from their bodies [18].

2.5.1. Evaporation

Evaporative heat loss is the main thermoregulatory mechanism of cows under high air temperature conditions because sensible heat loss is limited by the small temperature gradient between body surface and warm environment [34, 14]. Thus, a cow's ability to endure hot environments is dependent on the amount of heat it can dissipate via evaporation, either by sweat from the skin [15] or through the respiratory system [31].

2.5.2. Water Loss Through Urine and Faces

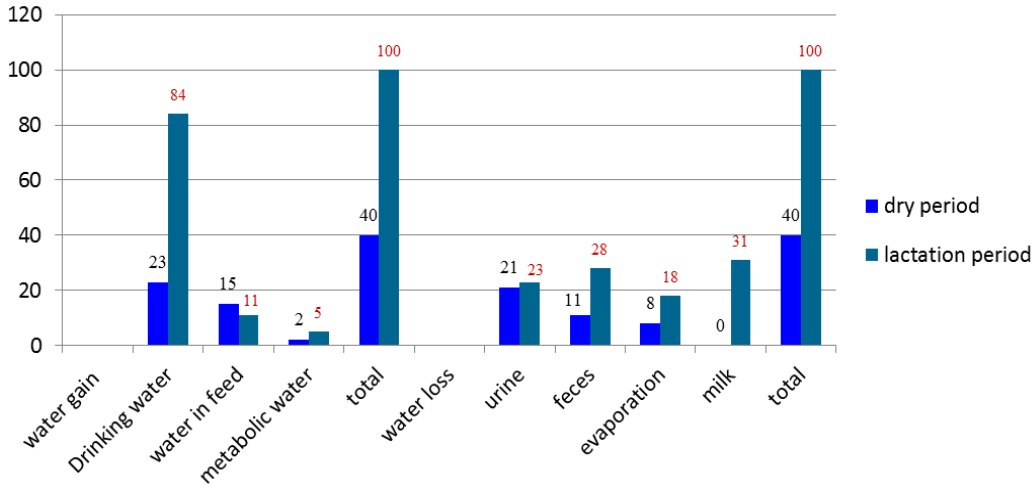
Poultry produce feces equal to 3-4% of their live weight [11], and since a chicken excretes an average of 60-70 g per day, the water loss from feces alone is about 2-2.5 g. Small cattle excrete about 4-5 kg of solid feces and about 0.5-1 kg of urine per day [38]. These amounts may vary depending on the animal's productivity level and feed consumption. The water

content of chicken eggs is 88%, cow's milk is 88%, chicken meat is 75%, goat milk is 86%, and sheep's milk is 81%. Agricultural animals excrete water through the excretory system in the form of urine and feces. Water loss will be equal to the amount of water in the product composition, depending on how productive the animals are. Additionally, through respiration and perspiration, animals lose water from their skin and lungs. Because of their smaller bodies, lower metabolic activity, lower production levels, low moisture content in their faces, and large salivary glands that secrete 15 kg of saliva per day—more than cattle do when measured by body weight—sheep are better suited than cows to survive in environments where there is less water available than what is needed during the day [30].

2.6. Water Balance

The animal's water balance is the difference between its water intake and losses, and the three main ways that it can lose water are through urine, feces, and transpiration. Urine is a crucial pathway for the excretion of water-soluble metabolic products. Daily fluctuations in the body's water content are minimal. This suggests that, for a brief period of time, water intake and loss are roughly equal. To maintain water balance, the body must lose the same amount of water each day as it takes in. A water imbalance can manifest as either a surplus or a deficit, and the regulatory systems need to be able to address both [33].

The diet consists of hay, silage, and concentrate. More concentrate and less silage is given in the lactation period than during the dry period. (Courtesy of H. Volden).



Source [33].

Figure 1. *Water balance (Litter per 24 hr) in cow during the dry period and during lactation.*

To maintain a stable internal environment and support normal production, a cow's water loss and intake must be balanced. As a result, lactating cows need more water than dry cows, and the type of feed is a major factor in determining daily water intake through direct drinking. A lactating cow that produces 35 liters of milk per day loses about 31 liters of water per day through milk secretion, while a dry cow does not lose water through milk production.

3. Conclusion

Water is very important for farm animals, playing a crucial role in physiological function like normal development of body, digestion, metabolism, thermoregulation, and production. The water requirements of farm Animal are different it depend on body size, production level, environmental conditions, and diet composition. Dairy cows, for instance, require high amounts of water due to milk production, layer hen also required high and clean water per day with free choice.

Water balance in animals is the ability maintained through intake from drinking, feed, and metabolic processes, while losses occur through respiration, perspiration, excretion, and production (milk, eggs). Environmental factors such as temperature and humidity significantly impact water consumption, with higher temperatures increasing intake. Ensuring adequate water supply of good quality is vital for optimal growth, reproduction, and overall health in farm animals. Proper water management strategies should be implemented to support animal welfare, maximize productivity, and promote efficient livestock production systems.

Abbreviations

NRC	National Research Council
NASEM	National Academies of Sciences Engineering and Medicine
NRAES	Northeast Regional Agricultural Engineering

	Service
ILRI	International Livestock Research Institute

Author Contributions

Abebe Mosneh: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Muluken Getachew: Writing – review & editing, Visualization

Conflicts of Interest

The authors declare there is no conflict of interest.

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