Chapter 1

Introduction

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Importance of water

Water fulfills a wide range of physiological and chemical functions and plays an essential role in all life processes (King, 1983; Murphy, 1992). About 99 % of all molecules in the body are water, which forms about 70 % of the body mass of the animals (MacFarlane and Howard, 1972).

Water is used for two main functions: intermediary metabolism for normal rumen fermentation and metabolism, proper flow of feed through the digestive tract, nutrient absorption, and normal blood volume (King, 1983; Murphy, 1992). Another function of water is to dissipate internal or absorbed heat by evaporative cooling through sweating or panting (King, 1983; Murphy, 1992).

Water balance

The total body water is all the water in the animal body including that inside and outside of cells (MacFarlane and Howard, 1972), and must remain practically constant in the long term (King, 1983). Accordingly, all water loss (evaporative, urine, faeces and milk production) must be compensated by an equal intake (drinking water, water in feed and metabolic water generated by oxidation of organic compounds) by the animals (Maynard et al., 1981; King, 1983; Murphy, 1992; Freer et al., 2007).

Feeds contain variable amounts of water depending on the moisture content, which may range from as low as 5 % in dry feeds to as high as 90 % or more in juicy plants (Sirohi et al., 1997). Water consumption of animals tends to be higher on feeds that contain high protein or fiber content, because animals need a higher water turnover for the excretion of nitrogen in the urine (Ferreira et al., 2002).

Oxidation of organic compounds can be used to produce metabolic water by animals under harsh conditions such as heat when water is needed for heat dissipation by vaporization (King, 1983). One gram of metabolized carbohydrates, fat and protein yield 0.56, 1.07 and 0.42 gram water, respectively (Maynard et al., 1981).

Faecal water represents a larger source of water loss than urine. Therefore, the ability to extract and reabsorb faecal water in the colon is important for the water balance and this ability is different between species with higher ability of goats to produce dried faeces than sheep or cattle (Silanikove, 2000).

Furthermore, livestock species vary in terms of their ability to concentrate urine and / or decrease renal urine flow and retain substances to the body fluids depending on the concentrating ability of the kidneys (King, 1983). Arid adapted species (sheep and goats), which produce urine that is more concentrated, have longer loops of Henle than do other species (e.g. cattle) with short loops (MacFarlane, 1968b; McNab, 2002). More details are presented in chapter 3. The amount of water saved by concentrating the urine is relatively small compared with that lost by evaporation. This pathway of water loss is the major mechanism for body temperature control. Cutaneous evaporation is dependent upon the activity level of the animal, ambient temperature, humidity, and wind speed (King, 1983).

Livestock that are well adapted to arid areas may be able to tolerate food and water shortage for several days depending on oxidation of their fat deposits (hump of the camels and fat tail of the sheep) and other physiological and behavioural mechanisms (Silanikove, 2000). MacFarlane and Howard (1972) found that camels who were dehydrated by 20 to 25 % replaced 60 % of the weight lost as water (80 – 100 l) in the first drink, while sheep and cattle replaced 75 % of the body weight. The animals replaced all the weight lost from dehydration in 1 or 2 days. In this context, Adolph (1982) divided mammals into two categories: those, which refill water lost rapidly, and those, which do so gradually. Silanikove (1989) reported that upon rehydration, cattle may drink up to 18 % of their body weight, sheep 20 %, camels 25 % and it may reach 40 % in the desert black Bedouin goats, within 3 - 10 minutes. In general, ruminants can replace 15 - 20 % of their body weight at the first drinking and 20 – 25 % within 1 - 1.5 hour (King, 1983).

Factors influencing water balance

Several studies documented that livestock vary in terms of their water requirements (Table 1) depending on several factors that influence their water intake due to their genetic differences (Tajane et al., 1992), physiological status and age (Das et al., 1999), animal activity (Pond et al., 1995), body size (Daramola and Adeloye, 2009), species or breed (Aganga et al., 1989; Squires, 1993; Silanikove, 2000; Ferreira et al., 2002), environmental temperature and humidity (King, 1983; Murphy, 1992), dry matter intake (Nocek and Braun, 1985; Silanikove, 1992), feeding regime and food consumption (King, 1983; Sirohi et al., 1997; Salem et al., 2006), milk yield (Hamadeh, et al., 2006), water availability (Alamer, 2006), water temperature (Savage et al., 2008) and disease status (King, 1983; Murphy, 1992).

Marked differences appear between ruminants and monogastric animals in their water requirements and their tolerance of water shortage because ruminants have a large fluid reservoir (the rumen), which can store large volumes of water to be used under water shortage condition (Silanikove, 1992; Burgos et al., 2001).

Recommendations on water consumptions for livestock are summarized in Table 1. Water consumption varies widely among the different classes of livestock and is influenced by factors such as climate and type of feed being consumed.