Discover Food

Review

A review of dairy production and utilization in Ghana and Benin

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Received: 31 May 2023 / Accepted: 18 July 2023
Published online: 31 August 2023

Abstract
High dairy production and utilization have proven very effective in improving food and nutrition security in society, especially among the rural poor. This review sought to find out the status of dairy production and utilization in Ghana and Benin, the challenges, and the way forward. The review discovered low dairy production in both countries which meets only about 19% (Ghana) and 20% (Benin) of dairy demand. This low self-sufficiency compels both countries to depend heavily on imported dairy products to meet consumers' dairy needs. However, dairy consumption in both countries is still abysmally low (Ghana = 9 kg/person/year, Benin = 8 kg/person/year). Cow milk is the most regarded and consumed animal milk in both states and is consumed both raw and processed. Local dairy products include "wagashi" (local soft cheese), yoghurt and "brukina"/"dègué" (fermented milk-millet beverage). Some of the challenges found include low patronage of dairy farming, low-performing breeds, safety issues, inadequate sustainable pro-dairy policies, water and pasture/forage shortages, inadequate infrastructure, poor education, unorganized local sector and climate change. However, adopting effective pro-dairy policies, effective safety and quality regulations, smart dairy farming and processing and exploring other dairy options like goat, sheep, and donkey milk is key to improving dairy production and utilization in both countries and beyond.

Keywords Dairy products · Production · Utilization · Challenges · Remedies

1 Introduction

Milk and dairy products have played and continue to play key roles in human livelihoods. They have been particularly integral to human diet and nutrition for centuries [1, 2]. These food materials sustain lives in almost every corner of the globe and are strongly gaining ground as a staple in Western Africa, especially in the Fulani community [3]. Milk is reported to be the world's third-biggest supplier of dietary energy and the fifth-largest provider of protein and fat [4]. Dairy foods are almost complete in every nutrient, thus making their consumption highly beneficial to human health, growth, and development [1, 5, 6]. They are specifically endowed with vital nutrients such as high-quality protein, fat, minerals, vitamins (A, Bs, C D, E), and antioxidants (carotenes, folate) which play pivotal roles in human health and growth [7–9]. These foods not only directly provide employment and income to people, but also indirectly do so by contributing immensely to consumers' health and energy status to work to earn a living.

There are several sources of animal milk such as cows, camels, goats, sheep, buffalos, horses, and donkeys among others [10–13]. However, cow is the global largest (81%) milk source, followed by buffalo (15%) while the others collectively

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make up 4% [11, 12]. An FAO dairy review indicated that about 930 million tonnes of milk was produced globally in 2022 [14], and is expected to grow by 1.7% yearly for almost a decade from now [4]. Global milk production giants include India, the European Union, the United States of America, Pakistan, China and Brazil [14, 15], in descending order. The production forecast for Asia, Europe, North America, South America, and Oceania stood at 419, 232, 132, 66, and 30 million tonnes in 2022, respectively [16]. Africa, though the second largest continent in the world, is one of the least producers of milk, with its value hovering around 50 million tonnes for the past few years [14, 15]. This indicates that the whole of Africa contributes only about 5%, which is woefully lower than the 45%, 25%, 14%, and 7% respective contributions of Asia, Europe, North America, and South America. In Africa, the leading milk producers are South Africa, Ethiopia, Sudan, Kenya, Egypt, and Algeria which collectively account for about 50% of the continent's milk production [17].

Milk is consumed raw or processed across the globe. Milk is processed globally into different kinds of dairy products such as various kinds of cheeses, yoghurts, creams, pasteurized milk, fermented milk, milk powders, evaporated milk, skimmed milk, condensed milk, and milk-based local products, to mention a few [14, 18, 19]. Dairy processing is comparatively more advanced and well-established in the developed and more industrialised world due to availability of advanced processing technologies and equipment than in the underdeveloped world [20–23]. Global milk consumption stands at 112 kg/person/year [24].

While these global statistics on dairy production and utilization are available, such on Western African countries like Ghana and Benin are not easily accessible, if not limited. This review thus seeks to give an overview of dairy production and utilization in these two countries including challenges faced and to proffer remedies based on what other nations have done or are doing differently to improve their dairy sectors. This review will be of great importance to decision-makers, researchers, business-oriented individuals and groups, and other stakeholders in the dairy sectors of the two nations and beyond.

2 The contribution of dairy products to nutrition and human livelihood

Dairy foods have been a great source of nutrition and livelihood for humanity dating back to 4000 BC [25]. These foods have been valued as one of the most complete foods in nature and are thus considered pivotal for human nutrition and health [9]. On a global level, milk and dairy products contribute about 18–20% of protein intake in adults [9, 26, 27]. Animal proteins, of which dairy proteins are a part, have superior digestibility to plant proteins [28, 29]. This contribution will most likely be higher in children and adolescents as they consume relatively higher quantities of dairy foods than adults. In sub-Saharan Africa, however, dairy foods only supply about 4% of protein intake [30]. Proteins form the foundation and structure of many critical parts of the human body ranging from cells to organ systems. Though protein is primarily known for tissue repairs and replacements, and growth and development due to its body-building ability, its roles in digestion, metabolism, immune health, dental health, and others cannot be undervalued as it remains a central constituent of the major players involved in these processes [8, 31].

Minerals from animal sources including dairy are reported to be more bioavailable to the human body than those from plant origin [31] possibly due to the low/no presence of nutrient inhibitors. Globally, dairy foods contribute to about 29–31% of children and adolescents [32] and 25–29% of adults [9, 33] phosphorus intake. They provide as high as 50–73% and 52–55% of calcium intake in children and adolescents [32] and adults [9, 33], respectively. Calcium and phosphorus are paramount for healthy bones, teeth, and muscles. Phosphorus plays other important roles in energy production for the body in the form of adenosine triphosphate (ATP), the composition of phospholipids and nucleic acids, and regulation of protein synthesis [31, 32]. Milk and dairy products can also contribute about 35–50% of children and adolescents' dietary iodine [32] and 26% of that in adults [33]. These numbers, however, may vary as a result of variation in iodine content in milk due to variations in feeding and management practices [34]. Iodine, on the other hand, is very crucial for the production and functioning of thyroid hormones to regulate metabolism [32]. These hormones are very critical for growth and development. Thus, the consequences of the absence of or deficiency in iodine in the body are dire, some of which include impaired growth and cognitive power, goitre, miscarriages, and stillbirths.

Dairy foods also account for about 23–59% of vitamin B12 intake in children and adolescents [32] and 26–32% of its intake in adults [9, 33] 28–38% of vitamin B2, and intakes in adults [9, 32, 33]. Additionally, they provide about 42% and 34% of retinol and total vitamin A intake of people aged between 3 and 19 years [32].

Weight management, low type 2 diabetes risk, low blood pressure, and cardio-protective effect have been positively linked with the consumption of dairy foods [33, 35]. These foods possess physiological functions aside from their conventional nutritional roles due to the presence of biologically active compounds [31]. Dairy protein provides bioactive peptides that have anticarcinogenic, hypotensive, immunomodulator, and antihypercholesterolemic properties [31]. There is also evidence of the beneficial roles of dairy fatty acids on health. Miciński et al. [36] revealed the ability of short- and medium-chain fatty acids to avert cancer, hypertension, ulcerative colitis, and atherosclerosis, inhibit inflammatory and bacterial effects and boost immunity. The positive impacts of milk fats on the prevention and treatment of health issues such as obesity, stroke, and cardiovascular diseases have also been reported [36–39]. An inverse association between milk and dairy products consumption and type 2 diabetes and cardiovascular diseases has been widely reported [40]. However, long-term, randomized and well-controlled studies are required to fully uncover the contribution of dairy foods consumption to cardiometabolic health as research is still growing in this aspect [40]. Dairy foods provide not only nutrients but also satiety and sensory enjoyment to consumers. Thus, the consumption of milk and dairy products contributes significantly to human growth and development, overall health and well-being.

Dairy foods are also a source of employment and income for many stakeholders in the dairy value chain [41, 42]. The dairy sector has employed many people directly and indirectly. Owners and employees of the dairy industries make a living, sustaining their lives and families with their earnings from these industries. Everyone in the dairy chain, from primary producers, processors, distributors, and wholesalers to retailers, largely depends on the income from the sales of dairy foods for their financial needs and wants. About 14% of the global population depends on dairy farms for survival and livelihood while every one million litres of milk produced creates about 200 on-farm jobs [42]. According to FAO [4], the dairy sector hires close to 240 million people worldwide. A study from Ghana, Kenya, and Bangladesh indicates that every hundred litres of milk creates close to six full-time jobs in those countries [43]. Informally, dairy sales account for about 50% of the financial needs of the Fulani community [44]. The value of dairy foods in sub-Saharan Africa stood at about 11% of total food production in the early 1990s but may be higher presently [30]. Dairy foods are therefore an important source of income to sector actors and stakeholders in other spheres of life such as utility bills, hospital bills, school fees, and other social responsibilities [44–46]. The dairy sector is a great contributor to women's empowerment in livestock keeping. About 25% of the about 150 million dairy farm owners are women and about 80 million dairy farmers are women [4]. In Ghana and Benin, a lot of women are involved in the dairy value chain [3, 45].

Thus, dairy foods contribute in no small way to meeting the United Nations' Sustainable Development Goals (SDGs) such as zero hunger and poverty, food and nutrition security, healthy lives, gender equality, and productive employment in society [4, 47].

3 Milk production in Ghana and Benin

Ghana's milk production is mainly from cow milk, unlike other parts of the world where there are alternatives such as milk from other animals. Ghana has a cattle population of about two million [3]. The annual cow milk production quantities, according to FAO [48] statistics, in Ghana and Benin over the past six decades have been split into two: 1961–1990 (Fig. 1) and 1991–2020 (Fig. 2). The number of milk-producing cattle of the two countries in the same period has also been presented in like manner (Figs. 3 and 4). The production values in Ghana for the considered period are mainly those imputed or estimated by FAO, with the only official being recorded in 2006 [48].

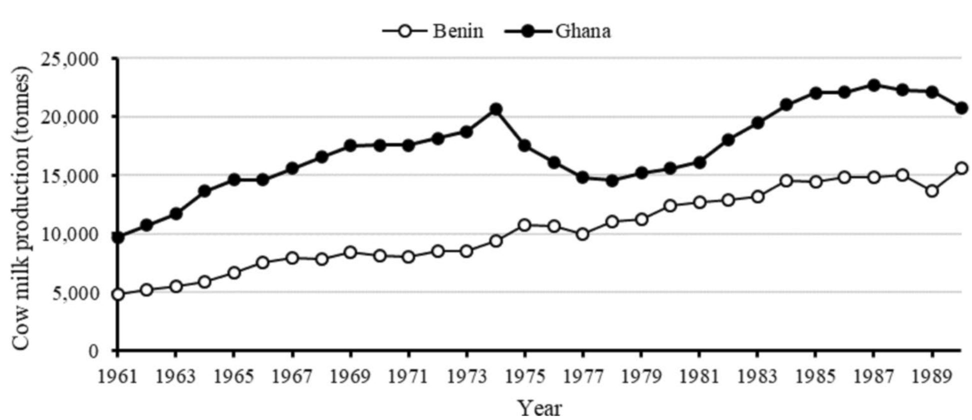

Fig. 1 Annual cow milk production (tonnes) in Ghana and Benin from 1961 to 1990. Source: [48]

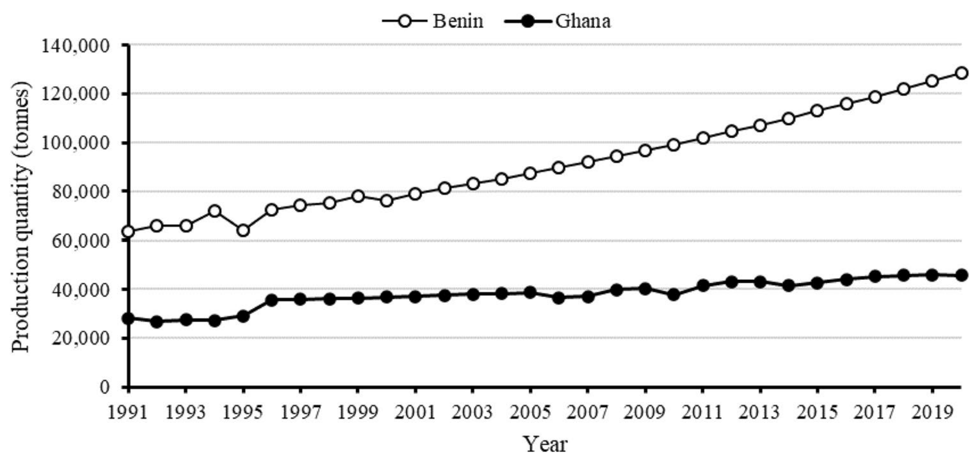

Fig. 2 Annual cow milk production (tonnes) in Ghana and Benin from 1991 to 2020. Source: [48]

The annual milk production in Ghana ranged from 9750–22,750 tonnes with an average of 17,282 tonnes from 1961 to 1990. The milk production increased considerably from 1961 (9,750 t) to 1974 (20,670 t) but declined sharply to 14,560 t four years later before gently picking up again (Fig. 1). A production growth of 113% was recorded from 1961 to 1990. However, from 1991 to 2020, Ghana produced 26,892–46,180 tonnes of milk, averaging 38,020 tonnes. with a growth of 72%. Ghana's milk cows averaged 132,939 from 1961 to 1990 (Fig. 3) and 272,500 from 1991 to 2020 (Fig. 4). The production values seemed to be greatly influenced by the number of milk-producing cows as shown in Fig. 3. This is because the number of milk-producing cattle followed a similar trend, suggesting that the milk production quantities were mainly dictated by the number of milk-producing cows. Over 90% of Ghana's fresh milk is obtained from the pastoral dairy production system [3, 44]. These pastoralists are mainly Fulanis and some native herdsmen in the northern part of

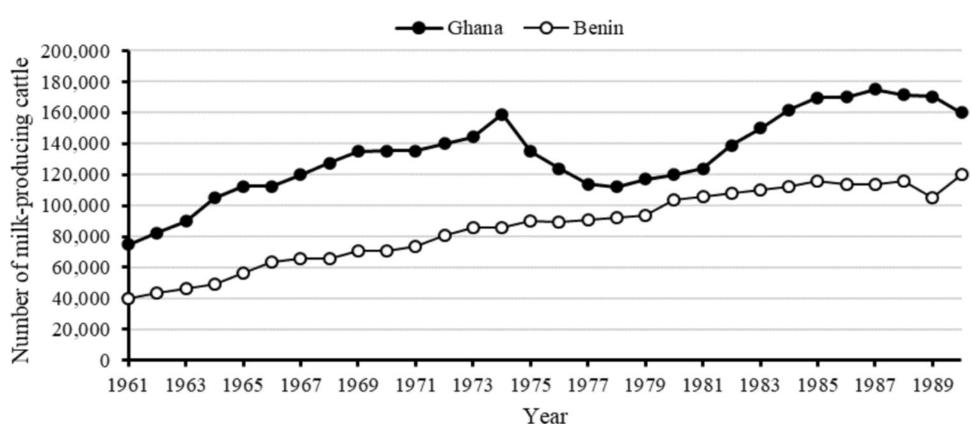

Fig. 3 Total number of milk-producing cattle in Ghana and Benin from 1961 to 1990. Source: [48]

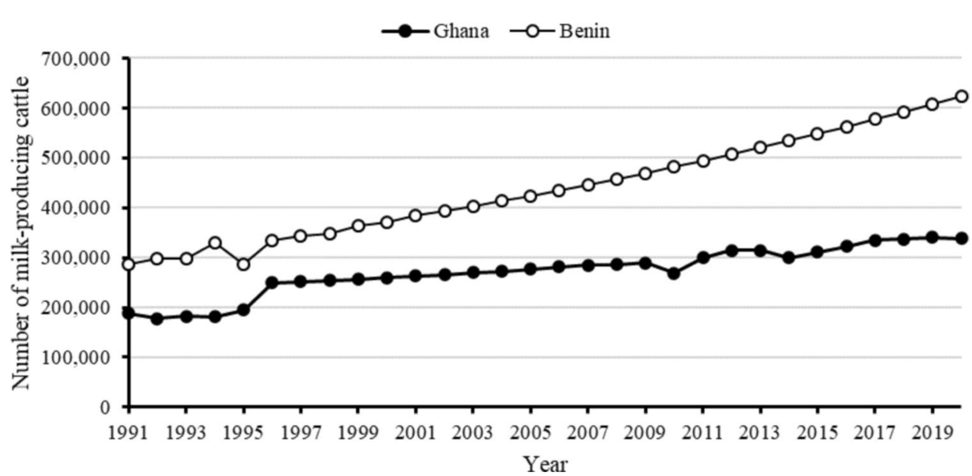

Fig. 4 Total number of milk-producing cattle in Ghana and Benin from 1991 to 2020. Source: [48]

the country. The Fulanis, also called Fulbe, Peuhl or Fula, are an ethnic group largely found in the Savannah-Sahel zone of Africa and mainly known for their semi-sedentary and nomadic pastoralism [49–51]. They mainly depend on cattle herding for their livelihood [51].

Ghana's milk production is seasonal, with higher quantities coming in during the rainy periods of May to September and April to November for the northern and southern parts of the country, respectively [44]. Generally, daily milk production per cow is very low, about 0.8 and 0.4 kg for the rainy and dry seasons, respectively [3]. This is because the local dairy cattle breeds, mainly the Ghana shorthorn, generally have lower genetic milk production potential compared to the crossbred and exotic ones regardless of the feeding and husbandry treatments [52, 53]. However, the higher milk production in the rainy season is mainly a result of the availability of sufficient fodder and water to farm animals. It is reported that the quantity of milk produced locally only meets about 19% of the local demand and thus is hugely inadequate to meet the milk demand of the Ghanaian people [44]. Consequently, the country has resorted to the importation of milk and milk products to meet demand [44, 54, 55].

The milk production values in Benin from 1961 to 2000 are imputed or estimated while those from 2020 are official [48]. However, Benin's production has been massively higher and increasing more sharply than that of Ghana in the last three decades. Benin's annual milk production ranged from 4824 to 15,600 tonnes with an average of 10,361 tonnes from 1961 to 1990, almost twice lower than that of Ghana in the same period. However, in terms of growth, Benin's production grew by 223% in that time frame. From 1991 to 2020, however, Benin produced 63,748–128,415 tonnes of milk whose average (91,457 tonnes) was almost thrice that of Ghana. The number of milk cows of Benin ranged from 40,201 to 120,000 from 1961 to 1990, with an average of 85,896 cows and from 286,794 to 623,376 cows, with a yearly average of 438,000 cows. As indicated above, the trend of milk production seems to be largely dictated by the number milk-producing cattle (Figs. 3 and 4). It therefore suggests that the number of milk-producing cows is the main driver of the milk production values of both countries. Reports also indicate that Benin has since the year 2000 considerably introduced exotic breeds of cattle such as Girolando, Gir and Zawak Zebu which have daily yields of about 4.5–12 kg to improve milk production [56, 57]. This initiative may partly explain Benin's milk production quantities in recent decades. Regrettably, Benin's milk production is beginning to take a downward trend as the value dropped from 128,415 tonnes in 2020 to 92,475 tonnes in 2021, about a 28% decline [48, 58]. The pastoral system also drives milk production in Benin [45]. This pastoral dairy production is mainly from the Fulani community and deals largely with cattle rearing and milk supply [45]. Out of the quantity of milk produced locally, about 53% is reportedly for home consumption while the remainder is sold to generate income to support the family [59]. Despite the considerable growth in milk production over the years in Benin, the quantity produced can meet only about 20% of the milk demand in the country, resulting in massive importation of milk and milk products from other countries [45].

4 Agroprocessing of dairy for value addition

Factors such as high perishability, limited availability, and limited patronage of fresh or raw milk trigger the need for processing it into more stable forms for longer preservation and use [60]. This resulted in the production of dairy products globally. Dairy products can be classified as cultured as in the case of yoghurt, fermented milk, some cheeses, sour cream, cultured buttermilk; liquid dairy products such as whole milk, evaporated milk, skimmed milk, cream; concentrated dairy products such as condensed milk; powdered dairy products as in the case of powdered milk; and frozen dairy products such as ice cream, frozen yoghurt and some cheeses [61–64]. Some of these products cut across almost every area of the globe while others are country- or location-specific. Products such as yoghurts, cheeses, powdered milk, evaporated milk, condensed milk, and cream, to mention but a few, are known worldwide. Most of these dairy products are produced and retailed by commercial dairy companies in both Ghana and Benin. Dairy companies such as Nestlé Ghana Limited, Fan Milk Ghana Limited, Emigoh Ghana Limited, Arla Foods Limited—Ghana and Promasidor are the leading commercial dairy operators in Ghana [3, 44, 65]. Nestlé Ghana deals with products such as powdered milk (Nido brands), evaporated milk (Ideal and Carnation milks), and infant formulas (Lactogen and Nan infant formulas) among others. Fan Milk is into the production and retailing of frozen dairy products such as ice creams and yoghurts (FanYogo, FanIce, SuperYogo, FanMaxx, etc.). Main dairy products of Emigoh Ghana, Arla Foods Limited—Ghana and Promasidor include yoghurts (Yomi yoghurt); powdered and liquid milk (DANO and UHT milk), butter and cheese (Arla® and Lurpak®); and powdered milk (Cowbell, Miksi and Mixwell fat-filled, Loya full cream and Loya Forvita milk powders), respectively. In Benin, commercial dairy companies include Ets. F. M. Grundmann Ltd (powdered milk products), STE. Saffron Sarl Benin (powdered and condensed milk products), Eddy Global Training Co. Ltd (powder milk products), Divine

Company (powdered milk products), and Mudabe Company Ltd (liquid and powdered milk products) among others. These commercial dairy companies from both countries rely heavily on importation (largely from Europe and other parts of the world) to stay in business due to inconsistent, insufficient, low-quality local milk supplies [56, 57, 65, 66]. Ghana, for instance, has a dairy market value of about USD 350 million [65]. Unfortunately, local fresh milk production struggles to even make up one percent of this market value [65]. This huge market gap together with high unmet demand has resulted in a continuous rise in the importation of milk and dairy products over the years, currently above 40,000 tonnes yearly at a cost of about USD 127 million [3, 44, 65]. Powdered (dry skimmed and whole) milk has been the most dominant imported dairy product in Ghana compared with other dairy products such as fresh whole milk, evaporated milk, condensed milk, cream, cheese, and yoghurt [3, 65]. This may be due to powdered milk's handling and transportation convenience and ability to be reconstituted for the onward development of most of the other dairy products. This possibly explains why imported powdered milk is the fundamental ingredient of many dairy products such as yoghurts and whey products produced by local dairy companies [44]. Condensed and evaporated milk are also imported in large quantities because of their wide consumption in teas, coffees, and porridges, and with corn flakes and sometimes in gari and millet flour soakings. Benin imports about one hundred thousand tonnes of milk and dairy products annually [56], which are worth tens of billion West African Francs [58]. Some of the dairy products Benin imports include powdered milk, whole and skimmed liquid milk, concentrated milk, cheese, yoghurt and butter, similar to those of Ghana [56]. The import volumes particularly increase considerably from November to March/April when milk production from the informal dairy sector declines steeply and demand for milk and its products rises significantly [44]. Individual production and importation volumes of these companies are however inaccessible.

Nonetheless, it is important to note that some of the internationally known products such as cheeses have local variations and names that are specific to countries and sub-regions. In West Africa, for instance, locally produced soft cheese bears local names such as "wagashi(e)", "waragashi", "wara", "warangachi", "warankashi", among others [19, 67–69]. This cheese is made using *Calotropis procera* plant parts as the main coagulants even though other plant sources are recently being considered [67, 68]. In the Ghanaian context, soft cheese goes by "wagashi" [3, 19, 69] and "waragashi" or "wagashi" in Benin [45, 67, 70]. The preparation of the local soft cheese follows similar procedures in the West African settings including Ghana and Benin. Generally, unfermented (raw) milk is filtered, warmed (50–70 ℃) and extracts of *C. procera* leaves or stems are then added to the warmed milk, stirred and further heated at the same or elevated temperature till coagulation is achieved [56, 69–74]. The coagulated milk is then transferred into raffia/plastic baskets or meshes for the straining of the whey and moulding of the cheese into a particular shape [69, 72]. The cheese is then ready for consumption in raw form, fried or cooked and eaten as meat substitute. Another local dairy product is fermented milk-cereal beverage, known in Ghanaian settings as "brukina" [3, 44, 75] and as "dègué" in Benin [45, 58, 70]. This is made by adding steamed cereals (millet in most cases) to spontaneously fermented milk, a dairy product on its own known in Ghana as "nunu" [76, 77]. Another local product is mashed millet dough balls with liquid milk (fermented or unfermented), known in Ghana as "fura" or "fura" beverage [76, 78, 79].

5 Consumption of milk in Ghana and Benin

In Ghana and Benin, cow milk is the preferred animal milk for consumption and dairy food processing [44, 56]. Hence, milk from other animals such as sheep, goats, donkeys, and others plays little or no role in the daily supplies and consumption by natives. In both countries, milk is consumed in the fresh or fermented form with millet flour, *tuo zaafi* (TZ), porridge, gari (cassava grits), and baobab fruit powder as is done in many African communities [80, 81], sometimes with or without added sugar. Apart from "wagashi", "brukina", "nunu", "fura" and "dègué", import-based products such as powdered milk, yoghurt, and ice cream are also consumed but mainly by the financially-muscular class.

Globally, it is recommended that each child and each adult consume 720–960 g (3–4 cups) and 480–720 g (2–3 cups) of dairy foods daily, respectively [33, 82]. Benin has food-based dietary guidelines which include a 100–200 g of dairy foods, but such is inaccessible in Ghana [83–85]. However, the milk consumptions per person per year in the two countries are very low, 8 kg and 9 kg, respectively for Benin and Ghana [24], about 6.7% and 7.5% of the global minimum consumption requirement of 120 kg/person/year [86]. This suggests that, regardless of age, on the average each person in Benin consumes only about 22 g daily, and about 25 g in Ghana. This is woefully inadequate. Even out of the 8 kg and 9 kg per person per year rates, the local milk production levels of these two countries are only able to meet 20% and 19%, respectively [3, 44, 45]. This indicates that without importation, milk consumption might have been as low as 1.6 kg and 1.7 kg per person per year in Benin and Ghana, meagerly translating to about 4 g and 5 g per person per day, respectively.

6 Challenges facing dairy production and utilization

Despite the importance of dairy foods to humanity, there are some challenges that the dairy industries in Ghana and Benin face. Some of the challenges that befall the dairy sectors in Ghana and Benin include but are not limited to low patronage of dairy farming, low milk-yielding cattle breeds, low preference for fresh milk, veterinary services inadequacy, safety issues, dairy-related health concerns and allergies, inadequate pro-dairy policies, waste management, water, and pasture/forage shortages, inaccessibility of dairy farms, poor education level, and unorganized local sector [3, 19, 44, 56, 58, 87]. Urbanization and climate change, though not directly mentioned in the Ghanaian and Beninese contexts, are part of the challenges that hinder dairy production [88–93].

6.1 Low dairy farming attention

In Western Africa, dairy farming has not been greatly ventured into as compared to other areas of agricultural production. In this part of the world, people rarely purposefully engage in keeping cattle mainly for milk production [94]. Dairying is mainly practised as a side business where the farmers' main financial focus is on the sale of the animals, not their milk [60, 94]. Thus, emphasis is placed on ensuring that the cattle increase in number and weight for maximum income, not on milk production. Further, on this side of the world, less monetary value is placed on milk-producing cows compared to meat-producing ones. Thus, more priority is placed on keeping meat-producing cattle than dairy cattle. Local dairy companies' preference for and patronage of foreign milk sources for the production of dairy products is another factor that discourages local dairy farming. Taylor and Nicely [65] reported that of the USD 350 million dairy market value in Ghana, the value of local fresh milk production is less than 1%. This suggests that virtually all the money is spent on the importation of foreign dairy foods into the country as earlier reported by Agritrade [95] rather than on boosting and encouraging local milk production. Though the figures of dairy market value of Benin are inaccessible, the story may not be any different from that of Ghana. This phenomenon not only discourages new entries into dairy farming but also frustrates the few existing dairy farmers to exit it.

6.2 Poor milk-producing breeds

The unavailability of good milk-producing breeds is another aspect that hinders the progress of milk production locally [46]. Dairy farmers desire to produce enough milk to meet local demand and beyond. However, most of their dairy animals do not have the capacity genetically, coupled with periodic shortages of water and pasture, to produce high quantities of milk [52, 75]. The main dairy breeds are the West African shorthorn (WASH) and the Sanga [3, 44, 52]. However, these breeds have milk yields of about 0.5–4.7 kg/day and about 75–1212 kg per lactation period of 180–290 days [44, 52, 96]. Similarly, in Benin, *Bos taurus* (Lagune breed, Somba breed), Sanga cattle (Pabli and Borgou cattle), various zebu breeds (White Fulani,Goudali, M'Bororo) introduced within the context of transhumance are the main local cattle breeds [56, 97, 98]. Among the local breeds, the Borgou accounts for about 51% of the cattle population nationwide, with milk yield of about 0.8–2.5 kg/day [56, 57]. This suggests that local farmers may need to increase the numbers of milk-producing WASH to produce yields that can meaningfully supply local demand. This not only puts additional costs of feeding and veterinary check-ups and treatments on the farmer as the numbers of cattle increase, but it is also not eco-friendly and climate-smart due to the additional burden on the ecosystem. Keeping high milk-yielding breeds such as Jersey and Sanga-Friesian crossbreeds whose daily and lactational yields are 14 kg and 6.5 kg and 4480 kg and 1950 kg, respectively would have been ideal for dairy farming [52]. However, these breeds are exotic and highly unaffordable to poor local farmers.

There is also the issue of a lack of artificial insemination equipment and technicians to artificially fertilize low-milk-yielding breeds with the semen of high-milk-producing breeds [46]. The lack of milking technologies is partly accountable for the low milk yields recorded locally [44]. Unfortunately, governmental and non-governmental organizations seem not to prioritize dairy farming and thus hardly assist farmers in obtaining high milk-producing cows.

6.3 Low preference for fresh milk

The major contributory factor to the low consumption of dairy foods in Ghana and Benin is the low patronage of unprocessed milk. High hesitance of Ghanaians aside from the Fulani group and herdsmen to raw milk consumption in contrast to a high preference for processed dairy products due mainly to safety reasons has been reported [19, 44]. A high (about 85%) prevalence of lactose intolerance, a global phenomenon mainly caused by racial differences [99], and its attendant effects partly accounts for the unwillingness towards raw milk in Ghana [100]. Lactose intolerance, the genetic inability of adults to digest milk lactose due to lactase deficiency [101], is reported to be more prevalent among Africans and Asians [99, 102]. There is a genetically proven similarity between cattle milk protein gene distribution and lactose tolerance allele in humans, borne out of genetic-cultural co-evolution between dairy cattle and milk-consuming humans [101]. Although drinking milk may be available in supermarkets and shopping centres, it is pasteurized and mainly imported for foreign nationals [44]. Anihouvi et al. [56] also highlight a similar situation in Benin. This suggests that a greater percentage of milk consumption in Ghana and Benin comes from processed milk and milk products. This preferential shift is becoming a global trend as a 43% decline in liquid milk consumption and about a 169% increase in dairy product consumption have been recorded worldwide between 1975 and 2020 [103].

6.4 The extensive system of cattle keeping

The mode of dairy farming influences the amounts of milk that can be collected from the animals. In Ghana, cattle keeping is largely extensive, especially in the northern part of the country in the dry season. The animals are released to fend for and shelter themselves while the herdsmen go on leave to resume duty a few weeks into the rainy season. Thus, as long as the dry season tarries, milk is hardly collected which contributes significantly to milk scarcity in such periods. In the rainy season, the nomads roam with the animals, leaving the calves behind, in search of pasture and water. On arrival, the lactating cows are milked without delay in turns after the calves have suckled for a few minutes to trigger milk letdown. However, continuous movement is reported to reduce milk volumes [75]. Thus, both extensive and semi-extensive animal-keeping methods are unfriendly to increased milk production. Although intensive keeping is recommended for maximum milk collection, it is practically difficult and economically impossible for large herds in this part of the globe.

6.5 Inaccessibility to milk-producing/market centres

Towns and urban areas are great market niches with high demand for milk and milk products due to their high populations. However, cattle are largely raised on the outskirts of major towns and cities [42]. Most of the Fulani herdsmen for example have their settlements remotely located in the forest/bush. This makes delivery and timely access to milk very difficult which hinders the production of dairy products and discourages the frequent intake of local milk and dairy products. High transportation costs to remote milk-producing/market centres, coupled with bad road networks and security threats, greatly hamper milk collection in Ghana and Benin, and many other African countries. This does not support records of actual quantities of milk produced locally. The long distance between production centres and major consumption areas facilitates milk losses. The losses are particularly in the rainy season when the already bad road networks worsen amidst higher milk production volumes, rendering milk-producing villages inaccessible for milk collection [75]. Not only is milk largely produced in remote villages but also local dairy products like "fura", "brukina", and "wagashi" are mostly produced in milk-production areas and transported to the cities and towns. Thus, excess milk and dairy products are unwillingly left to deteriorate because of distance, transportation fares, and poor/unavailable roads.

6.6 Unorganized local dairy sector and inadequate data

The local dairy in many developing nations such as Ghana and Benin is unorganized and unstructured [104]. The lack of working and well-functioning dairy value chains is one of the major challenges that the local dairy sectors in these two countries face. On paper, there are dairy value chains in these countries but in reality, it is more individualistic than a value chain [3, 45, 75]. In Ghana and Benin, like many other places, dairy farmers and families serve as producer-sellers of their milk while local dairy product producers are also producer-sellers [44, 45, 71]. Producers mostly deal directly with consumers and most of the sales are done at the farmgate [105]. There are hardly any working milk collection centres in Ghana, apart from individuals who traditionally collect milk occasionally from producers to sell to consumers [3, 105]. In the past, milk collection centres had been built at the Amrahia Dairy Farm and Sege in the Greater Accra Region of Ghana but are currently not operating due to insufficient milk production [3, 44]. Producers of local dairy products such as "brukina", "fura", and "wagashi" get their milk supplies either from wives of milk producers in the market or from the producers themselves at the farmgate level [3]. There are barely any coordinated value chain activities and lateral relations among primary milk suppliers and dairy product producers.

Companies that depend on imported milk for production are the importers, processors, distributors, wholesalers, and sometimes retailers [3]. More intermediaries and agents are, however, involved in this category nationwide than that produced locally on small scales. The import-dependent value chain has more stakeholders in and outside the country. Some of the external agents include producers and distributors of imported dairy products while those within the country include secondary processors, re-packagers, wholesalers, and retailers [75]. Effective and well-functioning dairy value chains are critical for revamping the local dairy sector [106].

Another reason for the poor dairy production and utilization records may be inadequate data availability. Data on daily dairy production and utilization are scarcely available in both, Ghana and Benin, especially in the informal sector. Research-borne data is very key in decision-making and distribution of scarce resources towards development. Lack of research funding is one of main factors accounting for data scarcity in this part of the globe [107].

6.7 Water and feed scarcity

Water and pasture/feed availability challenges also impede dairy production and livestock production in general in Ghana and Benin, like many other places in Africa [87, 94]. Owing to low rainfalls and frequent droughts, water bodies such as streams, rivers, ponds, and even dams dry up. Thus, getting water to drink is often a big challenge to both animals and humans in many rural communities. Herdsmen have to lead their flock to very distant places in search of any source of water to sustain the animals [92]. In times of droughts, pasture or forage is highly scarce, even dry pasture is unavailable due to rampant bush burning. The consequences of severe thirst and starvation are under-reproduction, poor milk yields, and the deaths of animals [92, 108]. For example, some Tanzanian farmers lamented losing over 80% of their cattle due to feed and water scarcity caused by prolonged droughts and even as high as 200 cattle a day [92]. Although the degree of severity may differ from that of Tanzania reported above, it remains a fact that some dairy cattle in Ghana and Benin die as a result of feed and water shortages [58, 87]. This is particularly so when the cattle are released to fend for themselves in the dry season as in the case of some parts of northern Ghana. In times of water and forage scarcity, some farmers resort to purchasing water and feed to fend for their animals, which is economically unsustainable, especially for larger herds of cattle [46]. Those who are unable to afford, sell some of the animals to fend for the rest, consequently reducing total milk yields. Getting silage and hay to purchase in this part of the world is a big issue as silage and hay markets are hardly available, making the situation worse even for the financially able [66, 87]. Herdsmen/cattle owners, thus, have to grapple with these water and feed problems till the rains set in when their animals can have enough to drink and to graze.

6.8 Disease attacks and inadequate veterinary services

In Ghana, cattle have a general mortality rate of about 14% [3]. Aside from this, dairy farmers have to grapple with one disease attack or the other on their animals [88]. Prolonged extreme weather conditions such as elevated temperatures, resulting from climate change, lead to heat and oxidative stresses, metabolic disorders, and suppressed immune power, increasing the incidence of diseases and deaths [109]. Such conditions also facilitate the proliferation, distribution, virulence, and transmission of parasites and disease-causing organisms and their vectors [109]. These result in the emergence of new diseases and the re-emergence of others. Some diseases of cattle include foot and mouth disease, tick-borne infection, leptospirosis, campylobacteriosis, contagious bovine pleuropneumonia, bovine respiratory syncytial virus, brucellosis, clostridial disease, and dermatophilosis among others [110–112]. Yassegoungbe et al. [58] reported dairy farmer complaints in Benin about disease attacks causing lots of mortalities in their herds. To help promote and/or retain animal health, there is a need for adequate and quality veterinary services availability and accessibility. Unfortunately, veterinary services are inadequate and very difficult to access in very remote cattle-rearing areas [58, 87, 94]. The few available veterinary services are also very expensive and unaffordable to poor dairy farmers. This results in hesitance or rare patronage of such health services. As the health of the animal is negatively affected, its reproductive performance, milk yield, and quality dwindle [91, 92]. When this happens, dairy farmers' and producers' income fortunes are reduced while consumers' needs are unmet.

6.9 Poor waste management

Waste management has been an issue confronting livestock keeping [113–115]. Kraals (i.e., enclosures for animals) are sometimes used continuously for several years without any proper waste management and become very messy, especially after rainfall [116]. These kraals are often open and without roofs and the animals are exposed to all forms of weather changes such as rainfalls, heat, cold and storms, among others [66]. In many cases, the milking is done inside these waste-filled kraals. Most kraals in rural settings are enclosed within (compound) houses or just beside the house as in some parts of northern Ghana [3]. The waste is mostly collected when organic manure is needed during planting. Other times, herdsmen and cattle owners resort to shifting kraals where new kraals are made while the old ones with overdosed waste are abandoned without appropriate disposal strategies. This results in all kinds of pollution including milk, land, water, and air pollution, and related health effects to humans and animals alike and a corresponding reduction in productivity.

Another big issue with animal keeping is the emission of greenhouse gases such as methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2) [117, 118]. About 37% of agro-emissions worldwide come from animals either directly or from their droppings [118]. In terms of enteric emissions (emissions from the digestive processes of animals), cattle alone produce about 77% of the global value [4]. Methane constitutes the highest (51–67%) enteric emissions in cattle [4]. Enteric emissions result in losses of nutrient intake in animals. Enteric methane emission results in losses of about 6–12% of total energy intake and 8–14% of digestive energy intake [117]. This issue has received little or no attention in the developing world possibly due partly to limited knowledge of its occurrence. Yet, these greenhouse gas emissions contribute to global warming and climate change. It is, therefore, important that proper waste management schemes such as waste and by-product valorization be considered in the dairy sector [88].

6.10 Lack of cold storage facilities

It is recommended that fresh milk be refrigerated within 2–3 h after collection to avoid deterioration due to its high moisture and protein contents. Refrigeration is critically needed on this side of the world where ambient temperature generally hovers around 30 ℃, which accelerates milk quality reduction and perishability [56, 75]. Unfortunately, local milk producers barely have access to electricity or power plants, talk less about having refrigeration systems for milk and dairy products. Consequently, unused or unsold milk and dairy products are (grudgingly) discarded to pave way for new batches.

6.11 Poor education among local producers

Poor education is one of the impediments to milk production in Ghana and Benin. A study in Benin recorded over 84.3% illiteracy, 7.4% primary leavers, and 5.8% secondary leavers among 190 dairy cattle farmers interviewed in South Benin [58]. On the part of Ghana, Okantah et al. [119] reported 49% illiteracy, 18% primary leavers, 11% secondary school leavers, and 22% having Arabic education from 107 dairy managers in neighbouring districts of the nation's capital, Accra. Most of the local dairy processors in the informal sector also have limited education. Illiteracy rates could be worst in very remote areas of these countries. The inability to read and comprehend can adversely affect proper dairy management practices such as treatment administration, feeding, keeping good sanitation, and maintenance of good hygiene during milk handling [120, 121].

6.12 Issues of dairy-related health risks

Consumers and potential consumers sometimes are a bit hesitant to consume dairy foods because of perceived health risks.

To begin with, dairy foods are associated with lactose intolerance which occurs as a result of lactose indigestion due to a lack or low levels of the lactose-digesting enzyme, lactase in some consumers [122]. The uncomfortable and quite disgraceful feeling of releasing smelly gases anywhere engineered by lactose intolerance adversely affects the patronage of milk and dairy products.

The high chance of microbial contamination of raw milk such as from *Salmonella typhi* and *Escherichia coli* resulting in food poisoning is another health issue of concern to consumers. Some studies in Benin [56, 70, 123] and Ghana [87, 124, 125] have reported heavy microbial contaminations including all kinds of bacteria, anaerobes, moulds and yeasts and even thermo-resistant coliforms in locally produced raw milk. These were reportedly linked to poor hygiene and sanitation which ranged from poor milker hygiene, dirty milking and storage containers, dirty udders and teats, water source, waste-loaded milking environment, and poor post-harvest handling [87, 126–130].

Furthermore, it is required that quality parameters of milk such as freezing point, moisture, protein, fat, and inhibitor contents be determined and thresholds are given before usage for processing. This, in reality, scarcely happens in the informal dairy sector in Ghana [44] and many African countries like Benin by extension. These safety and hygiene concerns have raised fears about the intake of locally produced raw milk and shifted consumers' attention and interest to imported drinking and evaporated milk [44].

6.13 Unreliability and contamination of local milk supplies

Highly commercial dairy companies do not patronize locally produced milk mainly due to its seasonality and high processing costs due to contamination. Commercial dairy companies in the past had tried patronizing local fresh milk for production but were unsuccessful [3, 44]. This was mainly because of short supply and issues of heavy contamination. The local milk production volumes were significantly insufficient to meet the production demands of the commercial companies, which was even more erratic in the dry seasons. Not only were the local supplies insufficient, but they were also not meeting safety standards due to heavy microbial contamination. These commercial dairy companies had no option but to return to importation to remain in business.

6.14 Climate change

One of the main challenges facing the dairy sector and many other sectors is climate change. The change in the average weather conditions over a long period adversely affects water availability and quality; forage and feed availability and quality; disease (re-)emergence and transmission; and ultimately animal health, reproduction, and milk production [21]. Several studies have reported the impacts of climate change on dairy production and livestock production in general. The negative impacts of heat stress on dairy production in West Africa have been reported [91]. In that study, the West African region suffered 29–38 days of severe heat as in 2010, which might increase by nearly 22% from 2021 onwards, resulting in about an 11% reduction in milk production [91]. An earlier study found that each rise in heat stress reduces milk production by 99 g daily per cow [131]. Mauger et al. [132] also reported a 25% reduction in annual milk production in Florida, United States due to climate change. A loss of about 350 ml/cow/day of milk was reported in the hot seasons [90]. Heat stress is said to reduce forage intake by 18% and milk yield by 32% at temperatures of about 32 ℃ [133].

Drastically reduced rainfalls and frequent and long droughts resulting from climate change have caused a shortage of water and forage in many parts of the globe including Ghana and Benin. Pastoralists have lamented starvation and malnourishment of their cattle and the resultant great reduction in milk production due to water and forage shortages birthed forth by reduced rainfalls and prolonged droughts [92]. Shortage of water does not only affect livestock water intake but also feed production and pasture yields [93, 134, 135]. Change in climate leads to alteration in niches of species which compromises the ability to manage animal feed [93]. Although there is hardly any information specifically on the impact of climate change on dairy production in Ghana and Benin, high temperatures and carbon dioxide concentrations have been reported to adversely affect food production in general in Ghana [89]. Similar findings were recorded in 2020 about the impact of climate change on food crop production in Ghana [136].

6.15 Urbanization

Urbanization of previously rural and green areas has had a negative toll on dairy production. Areas that once were a good source of forage and pasture for cattle and other animals have now been occupied by buildings and humans with little or no space for cattle rearing due to population growth [66, 88]. A study by Kuusaana and Eledi [137] in Ghana shows how farming activities of all calibre are being forced out of greener and favourable areas to unfavourable locations and faraway villages due to urbanization. Animals like cattle are restricted to unauthorized places and their presence in certain areas is regarded as a nuisance or an offence [137]. The situation is worse for unregulated urbanization and non-adherence to land use plans largely occasioned by stiff customary land tenure resistance. This puts undue pressure on cattle owners to either sell their animals or leave them in the care of rural pastoralists at a fee. This reduces and discourages animal (cattle) production, consequently reducing milk production and dairy products.

6.16 Poor policies and safety regulations

The governments of Ghana and Benin have implemented some policy initiatives to improve their dairy sectors. Non-governmental organizations and private institutions have also made some initiatives in both countries such as the provision of training and extension services, animal genetics, vaccines and feeds [138].

Benin's government has executed some milk and meat sub-sectors development projects (PAFILAV and PROSEFILAV-PEL) aimed at improving access to quality production factors and production infrastructure and equipment, and small-scale processing [45, 139]. Ghana's policies have mainly been on the provision of training and extension services and access to credit and market facilities [140]. Ghana's policies and interventions have focused on livestock production in general with little purposeful consideration for milk production [3]. Projects such as the National Livestock project, Pan-African Rinderpest Control, Heifer International Dairy project, 1000 s + project, Livestock Development Policy and Strategies, Food and Agriculture Sector Development Policy (FASDEP I and II), and a few others had been initiated in the past to improve livestock production and milk production [3, 94].

Although some initiatives and policies have been made in both countries such as the provision of training and extension services, animal genetics, vaccines and feeds [138], these policies hardly realized their goals and objectives probably due to poor planning and implementation [45, 94] which is why the dairy sector in these countries is still underdeveloped. The current and ongoing Ghana government policy on agriculture, Planting/Rearing for Food and Jobs, is centred on crop production only while the Rearing for Food and Jobs policy is practically non-existing and unheard of lately. There hasn't been any deliberate, concrete, and sustained attention and focus on improving dairy farming in Ghana [141].

The local dairy sectors in both countries are largely informal and scarcely have product certifications or labels [56, 75]. Gunarathne and Boimah [75] found that only two local small-scale dairy processors out of about 59 sampled from Senegal and Ghana had regulatory authority certification. This makes enforcement of strict adherence to regulation standards very difficult. In contrast, the formal dairy sector which deals with certified and registered imported milk and dairy products is duly monitored and regulated by the appropriate regulatory bodies [44]. Nonetheless, regulatory bodies have not done enough to ensure that the informal food sector is properly and frequently monitored and regulated [44, 75]. This, thus, allows some health-threatening and unsafe food products to end up in consumers' stomachs, resulting in food-borne illnesses [142].

7 The way forward

It is without a doubt that there is high demand for dairy foods across the globe including in Ghana and Benin. To improve dairy production to meet demand and improve utilization, some suggested solutions have been proffered in the following sub-sections.

7.1 Effective pro-dairy policies and interventions

For the local dairy sector to thrive, effective holistic pro-dairy policies and interventions from government and non-governmental bodies are required [143, 144]. The policies and interventions should be unitized into animal feed and nutrition, health, and breeding, among others to ensure increased milk production. There should be policies and interventions that target improving the genetic milk-production capacity of dairy cattle rather than increasing the number of cattle which is not climate-smart [144]. There should be others that focus on education and training on dairy animal feeding, improved and innovative ways of dairy farming, disease prevention and treatment [3, 88, 143, 144]. More efforts should be made to have more veterinary officers stationed at every animal-keeping community to improve service accessibility. Capacity building of actors in the dairy value chain and dairy research funding greatly help to easily transmit knowledge and innovations [3]. There should also be drastic initiatives taken to discourage rampant bush burning while encouraging forage production to ensure all-year-round pasture availability for animals. Additionally, and more importantly, measures such as the creation of dry-season favoured dams and desilting of available dams, and prevention of water pollution activities to ensure water availability throughout the year for animals. Water availability and accessibility also help dairy farmers to have water to wash dairy utensils and practice personal hygiene. Gender-inclusive policies can also effectively support women's participation in the dairy sector and improve their access to training, resources and credit facilities which will help improve dairy production and utilization [145].

Although domestic milk production volumes are erratic and insufficient, production could be improved if the measures enumerated above are effectively implemented and local milk that meets regulatory standards is given prioritized consideration over imported milk for commercial dairy foods production [44, 104, 143]. Preference for local milk and dairy products, coupled with the provision of cold storage and preservation facilities, helps to curb post-production losses, especially in the rainy season where production volumes are relatively higher [75, 104, 143]. This serves as a great motivation for existing dairy farmers while encouraging others to embrace dairy farming.

7.2 Safety regulation of the local dairy sector

While efforts are being made to increase dairy production and utilization, regulatory bodies in charge of ensuring food products safety and quality approval and certification should be up and doing to ensure wholesome dairy foods are passed down to the consumer. Safety and quality standards should be made available and accessible to actors in the dairy value chain in a language or dialect understood by everyone involved [146, 147]. Deliberate steps should be taken to demonstrate and explain acceptable procedures and handling to all stakeholders in the dairy sector from the farmer/herds person through to the consumer without conferring knowledge on them [146, 147]. This helps to ensure milk quality right from the animal through to the consumer's mouth.

7.3 Smart dairy farming and processing

As demand for dairy foods increases, actors and stakeholders in the sector taking precise and innovative steps to improve production volume and quality while minimizing costs, losses, and environmental effects to remain in business is what is considered smart dairying [20–23, 148]. This encompasses all facets of the dairy chain from the dairy farm to the consumer. Smart dairying focuses on producing to meet specific needs and demands and not for the sake of producing. Thus, smart dairying thrives on the inclusiveness of everybody that matters such as farmers, researchers, dairy and dairy-related institutions and processors, technology and innovation developers, consumers, and other stakeholders [20, 22, 23]. Breeding innovations such as gene editing, artificial insemination, embryo transfer, hormone treatments, and cloning can be employed to amplify the milk production capacity of cows [20]. These are applied to improve animals' resistance to stress, disease, and climate change [149] and can be applicable and useful in the Ghanaian and Beninese contexts in that respect. However, inputs from important stakeholders such as farmers and consumers should be deliberately sought and considered to enhance acceptance and patronage by farmers [150] and to reduce rejection of the resultant dairy foods by consumers for fear of perceived unnaturalness [151].

Quality feeding and efficient feeding practices are also key in dairying. Feeds, pasture, and forage of high nutrient density and bioavailability should be fed to dairy animals in the most efficient and optimized ways possible to ensure maximum use and reduced wastage for healthy growth and maximum productivity [152–154]. Feeding practices such as feed supplementation and eco-friendly ones such as zero-grazing and silage feeding are increasingly being embraced in many parts of the world to improve milk production [21, 152, 155–157]. Manual feeding is gradually paving way for more efficient and less-labour-intensive automated and modelled feeding systems in animal keeping in other parts of the globe [158, 159]. Such systems could help to make gains in livestock keeping in western Africa, too. The issue of greenhouse gas emissions is also being curtailed in other jurisdictions through the inclusion of organic acids, oils, and extracts of plants such as seaweed and the use of high-quality forage and feed [20, 117, 118, 160]. The waste generated by the animals can be converted to bioenergy for domestic and industrial use while improving sanitation and animal health [114, 115, 149]. The use of solar-powered cooling systems can be very helpful, especially in rural dairy communities, for reducing spoilage and losses of milk and dairy products [149, 161]. The adoption of renewable energies such as solar power also helps reduce the dairy sector's carbon footprint while supporting sustainable production.

Another area of key concern is the milking process. Manually milking, a critical point for milk contamination, is largely practiced in Ghana and Benin [3, 19, 45, 56]. The use of milking devices is the way to go to guarantee the utmost milk yield, safety, and quality as well as for saving time, labour cost and reduce milking stress [162–165]. More importantly, low-cost methods like trainings on sanitary and hygienic practices can be very effective in reducing contamination during milking and handling.

Small-scale processing and value addition to milk can also improve farmer income levels, improve milk shelf life, and increase dairy products' availability and accessibility to consumers. Adoption of efficient technologies and automated systems by dairy processing companies can enhance dairy production and improve product quality [128, 161]. Seeking consumer inputs before product development, and rebranding or modifying existing products as per consumer demand and preference [166–168] can help improve dairy consumption in the countries under review herein.

7.4 Exploration of other dairy sources

The dairy sectors in Ghana and Benin have mainly relied on cow milk for dairy production. This is because of the traditional preference for cow milk in these nations. This has placed undue pressure on dairy cows as the demand for dairy products keeps rising by the day while other potential milk sources such as sheep, goats, and donkeys, which are indigenously available and kept by almost every household in rural areas, go unnoticed and unutilized [42, 169]. Several studies have highlighted the benefits of these non-cow milk sources as highly comparable to that of cow milk [60, 169–173]. Thus, it is necessary to make use of these dairy sources in this part of the world, too. Though change is very difficult, with nutritional education backed with scientific research evidence and gradual introduction into existing dairy products consumers will eventually develop a likeness for non-cow milk products. This will go a long way to help promote food diversity and utilization and improve food and nutrition security in the countries under review.

8 Conclusions

This review has revealed the great contributions of dairy foods to human livelihoods and food and nutrition security in society. The review has discovered low dairy production in both Ghana and Benin which meets only about 19% and 20% of dairy demand, respectively. Consequently, the two countries depend heavily on imported dairy products to meet consumers' dairy needs. Despite these, dairy consumption in these countries is still abysmally low (Ghana = 9 kg/person/year, Benin = 8 kg/person/year) when juxtaposed with a recommended intake of 120 kg/person/year.

The review also finds that cow milk is the most regarded and consumed animal milk in both states and is consumed both raw and processed. Milk is consumed in the fresh or fermented form with millet flour and/or with gari (cassava grits), sometimes with or without added sugar. Local dairy products include "wagashi" (local soft cheese in both countries), yoghurt, and a fermented milk-millet beverage known as "brukina" in Ghana and "dèguè" in Benin and milk-mashed millet dough ball beverage known as "fura" in Ghana.

Challenging issues such as low patronage of dairy farming, poor milk-producing breeds, veterinary services inadequacy, safety issues, dairy-related health concerns and allergies, inadequate pro-dairy policies, waste management, water, and pasture/forage shortages, inaccessibility of dairy farms, poor educational level of local dairy producers, unorganized local sector, urbanization, and climate change largely contribute to low dairy production and consumption in the countries being reviewed. However, effective and all-inclusive pro-dairy policies, proper and effective dairy safety, and quality regulations, smart dairy farming and processing involving sustainable and efficient production methods, small-scale processing and value addition, and exploration of other dairy options like goat, sheep, and donkey milk can help improve dairy production and utilization in Ghana and Benin, and other places. This can best be achieved through significant efforts from the government, private sector, community-based initiatives and public–private partnerships.

Acknowledgements The authors acknowledge the partnering institutions, University for Development Studies, Ghana, and the University of Göttingen, Germany.

Author contributions Conceptualization: MAA and LD. Investigation: MAA. Data curation: MAA and LD. Writing—original draft preparation: MAA. Writing—review and editing: LD and DM. Supervision: LD and DM. Funding acquisition: LD and DM. All authors have read and approved the final manuscript.

Funding Open Access funding enabled and organized by Projekt DEAL. This research was funded by the German Federal Ministry of Education and Research (BMBF) under the project named, DecLaRe.

Declarations

Competing interests The authors declare no competing interests.

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