

Review Article

Methane Emissions from Dairy Production Systems: Sources, Drivers, Environmental Impacts, and Mitigation Strategies: A Review

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Abstract

Methane is the main important greenhouse gas that emitted into the atmosphere by livestock during the process of enteric fermentation and manure management. Developing countries produce a large quantity of those emissions, caused mainly by inefficient animal rearing systems, feed production and manure management. Methane is emitted from livestock in developing countries and the mitigation actions that could be put in place to reduce atmospheric emissions and increase animal productivity. Developing countries are characterized by low Greenhouse gas emissions to the atmosphere and their potential impact on global climate have become important concerns world-wide. The impact of methane in industrialized countries, the situation is the opposite of developing countries. Livestock production systems, such as dairy farms, provide in both sinks and sources for greenhouse gas. Methane is produced during the anaerobic fermentation of hydrolyzed dietary carbohydrates in the rumen and represents an energy loss to the host besides contributing to emissions of greenhouse gases into the environment. The methane mitigation strategies require robust prediction of emissions from rumen and Diets high in concentrates can result in a lower emission of methane. Also diets with a high content of starch, such as alfalfa-grass, have a methane-decreasing. It is profitable to reduce enteric methane formation since that form of methane is unavoidably lost. Methane emissions from manure, on the other hand, are possible to reduce during storage and manure-derived methane can also be collected and used as biogas fuel. It is earlier shown that it is possible by dietary means to compensate a reduced enteric methane production by a higher or maintained production of methane from manure. The Therefore, improved feeding systems in dairy farms and provision of knowledge about methane emission transfer to dairy farmers are some of control strategies which contributes in methane gas reduction.

Keywords

Fermentation, Global Warming, Methane, Ruminant, Developing Countries, Ethiopia

1. Introduction

Methane is a colorless, odorless, and tasteless gas that is the primary component of natural gas which is a potent greenhouse gas (GHG) that contributes to the global warming. And it is poorly soluble in water, but soluble in organic solvents

has lipophilic nature [23]. The production of methane is conducted in an anaerobic environment by means of microorganisms by biological processes such as fermentation [8, 56]. Methane is mainly produced in the rumen by enteric fermentation

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and it leaves the cows by belching, exhaling or by the excreta. Approximately 1/3 of the GHG emissions from the agriculture are in form of methane and livestock accounts for almost all of these emissions [8].

This Gas (CH_4) is produced largely from bacteria that live in soil, water and the stomachs of ruminant animals (mammals that have a stomach with four compartments that ferment food as a major part of the digestion process). Methane is considered a greenhouse gas (GHG) because it can trap infrared radiation in the atmosphere, causing an increase in air temperatures and is the second most abundant global man-made GHG, behind carbon dioxide (CO_2), which comes largely from fossil fuel combustion [25].

Methane is one of the three main Greenhouse Gases (GHG), together with carbon dioxide (CO_2) and nitrous Oxide (N_2O) in the environment [49]. In addition, it has global warming potential than CO_2 due to the degradation of the ozone layer [51]. Methane is emitted from a variety of sources and its concentration in atmosphere has increased over the last few centuries [30]. Currently, the production of methane from livestock and its impact on climate changes are a major concern worldwide [37]. Methane is produced from enteric fermentation during the normal digestive process of ruminants which is correlated positively to the amount of dry matter fermented in the rumen which itself depends on feed composition and rumen fermentation characteristics of the diets [6, 22]. Still large gaps in knowledge are present which require substantial research. The effect of feeds on enteric CH_4 reduction could be due to a direct (suppression of microbial activity), or an indirect impact on microbial fermentation of feed and lead to different proportions of end-products that are not equivalent in terms of hydrogen produced [5]. The main sources of methane are classified as natural and anthropogenic in their nature. Therefore, natural sources of CH_4 emission in the atmosphere include permafrost, termites, oceans, freshwater bodies, gas hydrates, wetlands and non-wetland soils, volcanoes, wildfires and emissions sources of methane from enteric fermentation of the domestic livestock contribute significantly to GHG [50]. Whereas, the anthropogenic sources of methane emission are Landfills and oil, it is one of the three main Greenhouse Gases (GHG), together with carbon dioxide (CO_2) and nitrous Oxide (N_2O) in the environment [49]. However, Methane is important as a fuel for ovens, homes, water heaters, kilns, automobile, industrial chemical processes, transported as a refrigerated liquid liquefied natural gas and most important greenhouse gas after water vapor [34]. In addition, it is the principal component of natural gas used for turbines. The emission of methane is expected to be increased in the next decade's, especially in developing countries. Moreover, in the last five decades, enteric CH_4 emissions from dairy cattle grew by 12% and methane emission increases by 21% in developing countries whereas, the emission was reduced by 48% in developed nations [9]. Therefore, this paper is aimed to overview methane emission from dairy farms, sources, drivers and impacts of methane emission from dairy Farm on Global Warming

with its Method of Mitigation.

2. Methane Emission from Dairy Farms and Its Impact on Global warming

2.1. Methane Emission from Dairy Farms

Methane emissions have multiple processes from dairy farms, including enteric fermentation in animals and microbial processes in manure [12]. Cattle release methane because of microbial fermentation, which leads to breakdown of carbohydrates in the rumen, and large intestine, contributes significantly to the greenhouse effect. Cattle produce by far the largest part of CH_4 and dairy cattle contribute greater percentage of emitted gases [57]. Recently, livestock sector of agriculture is industrialized; manure management contributes an increasingly large proportion of methane emissions to the environment. In addition, enteric CH_4 is produced in the digestive tract by Archaea microorganisms as a by-product of anaerobic fermentation (methanogens) which results in 3-14% loss in gross energy intake, which largely dependent on composition of the animals' diet and level of feed intake [29].

Furthermore, CH_4 emissions by dairy cows vary with body weight, feed intake, diet composition and milk yield. This occurs when cows are fed the same diet at the same intake; however, variation between cows leads to a variation in the amount of CH_4 emissions. The huge amount of CH_4 that is emitted from livestock originates in the fore stomach, also called the rumen and this occurs in the rumen by methanogens, which converts H_2 and carbon dioxide into CH_4 and water [42].

2.2. Methane Formation in Dairy Farms

Methane formed when carbohydrates are broken down by microorganisms into small molecules enough to be absorbed in the bloodstream, through the digestive process of enteric fermentation, it brings the formation of methane in dairy cows as a by-product [26]. Dairy cows consume fibrous feed and produced methane as a by-product of ruminant digestion produced by methanogen Archaea microorganisms in rumen through fermentation result in the form of methane [41].

Methane Formation may have a negative impact on metabolizable energy available for production and reduce the animal's overall efficiency [24]. Energetic losses to the animal from CH_4 production are approximately 2 to 12% [28]. Potential mitigation of CH_4 of 25% could increase growth in beef cattle by approximately 75 g/d BW gain [43] or increase milk production by approximately 1 L/d [7]. Hence, reducing CH_4 production in dairy cattle is of energetic importance for producers. Fermentation of carbohydrates, proteins, and other organic compounds in the rumen by microbes results in various products, including volatile fatty acids, CO_2 , and dihydrogen (H_2) [42]. This gas production is one of the last steps in the long chain of fermentation as it uses the products of CO_2 and

H₂ to produce CH₄ by a process called methanogenesis. Methanogenesis is performed by methanogenic archaea in the rumen, often referred to as methanogens [42]. Methanogens use three major substrates for CH₄ production: CO₂, acetate, and a compound that contains a methyl group [42]. The majority of known methanogens use CO₂ and H₂ to produce CH₄ in a pathway commonly referred to as hydrogenotrophic [23]. Methane production is also closely associated with the breakdown of fibrous feed as the breakdown of fiber produces acetate, butyrate and H₂, with H₂ being converted into CH₄ [42].

Furthermore, cellulose in the manure is degraded by microbes (methanogens) and serves as a substrate for CH₄ production [12]. Anaerobic digestion is a natural process in which the microorganisms consume organic matter under an oxygen-free environment and produce CH₄, which is an important component of GHG. The composition of volatile solids contained in manure influence the anaerobic decomposition of organic matter and the formation of methane gas in dairy farms [18]. When amount of feed increasing CH₄ consumed in dairy cow's increases; the energy available for conversion to methane also increases. Through this enteric fermentation, animals like cows, sheep and goats are producing large amounts of CH₄.

Enteric fermentation occurs because of microorganisms in the stomach of these animals. This creates methane as a by-product that is either exhaled by the animal or released via flatus [37]. Methane is produced mainly in the rumen (87-90%) to a smaller extent (13-10%), in the large intestine [15]. The majority of methane emissions source in dairy farm is when animal exhaling CH₄ as a byproduct [15]. Methane forms where methanogen bacteria are present. Conditions favoring survival of methanogen bacteria are lack of oxygen, a redox potential below -200mV, neutral pH, nutrients electron acceptors such as NO₃ and a substrate rich in organic matter.

Livestock manure contains portion of organic solids such as proteins, carbohydrates and fats that are available as food and energy for growth of anaerobic bacteria. Manure from the dairy sector is managed in liquid systems that produce greater quantities of CH₄ emissions due to the multiplication of methanogen bacteria in the chain [52]. The anaerobic environment is a precondition for the production of CH₄ sources via microbial metabolism of organic material. In anaerobic conditions, the decompositions of fecal and bedding material produce methane after degrading of substance into volatile acids and the substances are used by bacteria to produce CH₄ [10].

2.3. Source of Methane in Dairy Farms

Sources of methane emissions are manure and enteric fermentation.

2.3.1. Manure

The term 'manure' is here jointly describing both the faeces and the urine produced by the animals without additions of bedding material or water. The main basic characteristics of

manures which are of importance for the potential of methane production are the content of volatile solids (VS), which indicates the content of incinerable substances at 550 °C, or the amount of carbon. The VS in manure can either be calculated from the dry matter intake (DMI) and digestibility of the feed or by analyzing the manure in laboratory [26]. However, a large part of the VS is not easily degraded by the microbes under anaerobic conditions and does therefore not contribute to the methane production [53]. The easily degradable VS have a direct influence on methane production from stored livestock slurry. A reduction in easily degradable VS would therefore reduce methane emissions from stored livestock slurry.

2.3.2. Enteric Methane

Enteric fermentation is a major source of methane emissions from ruminant livestock and is therefore an important target for greenhouse gas mitigation [22]. Methane production from enteric fermentation is part of the normal digestive process in animals, especially ruminants, where microbes that live in their digestive system ferment the food they eat. These emissions are primarily the result of animals belching or exhaling. There is different factor which affect enteric fermentation of methane gas. [28] suggested a range of factors that affect enteric methane emissions, such as feed intake, type of carbohydrate fermented, forage processing and lipid addition. These factors have their effects by two different mechanisms. The first mechanism described is the amount of carbohydrate that is fermented in the reticulo rumen. The second mechanism is the amount of available hydrogen and the consecutive methane formation through the ratio of VFA produced. The VFA's regulate the hydrogen supply which controls the production of methane. If carbohydrate would be fermented to acetic acid only, the energy loss from methane formation would be 33%. If the ratio of acetic and propionic acid was 0.5, the loss of energy as methane would be Zero% [59].

Factors affect enteric methane are;

1) Level of Concentrate and DM

When adding concentrates to the diet of lactating cows, the methane production increased [21]. When replacing the hay silage with maize silage, the methane production also increased, both these scenarios were however solely a result of corresponding increase in DMI and the diets with concentrate supplementation had a lower methane production per kg DMI than did the diets without concentrate. To reduce methane emissions, lauric acid can be used as a supplement to the cows' diet [32]. This resulted in a decreased enteric emission of methane by 20% but the decrease was also followed by a decreased feed intake.

2) Level of Carbohydrate in Feed

Different types of carbohydrates presumably influence methane production through impacts on pH in the rumen as well as on the microbial population [28]. A higher proportion of carbohydrates fermented each day (both fiber and starch) imply a lower methane production per DMI. The same is true for

feed intake since a higher DMI increases the passage speed which implies that less degradation occurs and consequently less methane is produced [39].

3) Feed Composition

Diets high in concentrates result in a lower emission of methane [21, 28]. When feeding diets of 90% concentrate the

losses of energy as methane might be decreased to half the commonly predicted value of 6% of diet GE [28]. A substantial part of the methane emissions from ruminants originates from crude protein, while fat and other ether extract components can decrease the emissions [13].

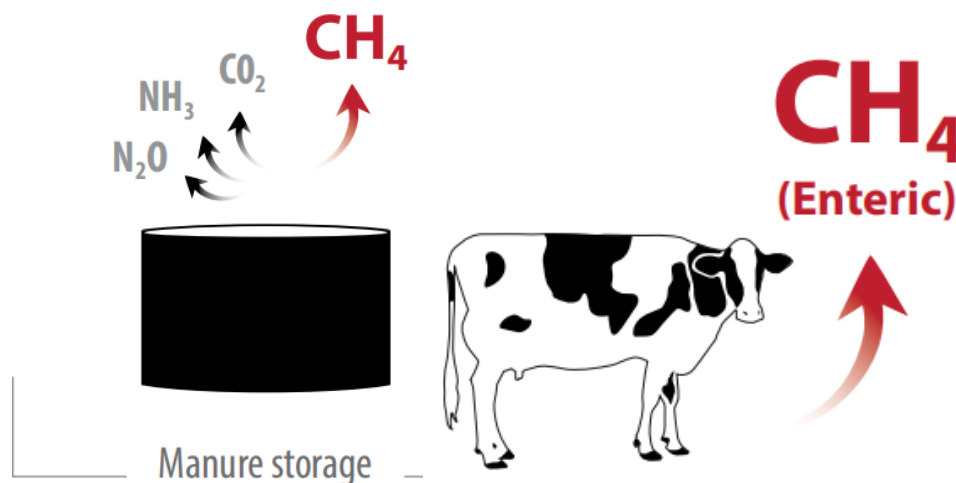


Figure 1. Source of methane in Dairy Farm.

2.4. Amount of Methane Produced

The amount of methane emissions produced calculated on livestock unit (LU is 500kg) in dry cows 106 kg LU from lactating cows. Lactating cows emit approximately twice the amount of CH_4 produced as compared to either dry cows or heifers, more amount of methane gas produced from lactating cows than dairy cows, this is largely due to their increased feed intake, although ration and animal size also have an effect. These emission factors may include emissions from feces deposited on the barn, floor, which would be much less than emissions from enteric fermentation [12].

Enteric CH_4 emissions from Holstein cows by using CH_4 analyzers at robotic milking stations. This has resulted an increasingly large amount of methane, which can manipulate CH_4 production using diet, by making changes, which affect the availability of hydrogen in the rumen. Amount of methane gas emissions from handling and storage of manure depends on the amount of manure produced, its nitrogen content and the proportion that decomposes anaerobically, also temperature [22]. Moreover, if manure is kept in the animal barn, some amount of CH_4 may originate from this manure. In dairy farms, the atmospheric air contains a small amount of methane gas when compared to respiration air of cattle. However, the concentration of CH_4 gases a mixture of air and excreted from the animal, currently, the production level to decrease. increasingly large amount of methane produced by cattle which CH_4 production using diet and also the amount of methane production is measured by absolute as well as relative units.

2.5. Condition Favors for Production of Methane Gas

Rumen fermentation is one of a condition, which produces methane from anaerobic fermentation of feeds, which takes place mainly in the rumen with a minor contribution from the hind gut. Complex succession of organisms takes part in the cooperative catabolism of substrates and the production of methane fermentation products. The diversity, size and activity of the microbial population in the rumen are largely determined by the diet composition of methane production. Methane gas production by two stages when breakdown of carbohydrate by rumen macrobiotic the first stage involves the hydrolysis of complex carbohydrates to glucose and performed by primary fermenters such as *Fibrobacter succinogenes* for the cell wall carbohydrates [42]. The second stage (microbial fermentation) of carbohydrate digestion involves the conversion of pyruvate, 3-carbon simple molecule, to different fermentation products through metabolic pathways that produce metabolic hydrogen [41]. Primary and secondary fermenters are involved in the degradation of simple sugars to the main products of rumen fermentation, such as VFAs (acetate, propionate and butyrate), hydrogen gas and CO_2 , whereas CH_4 produced in the final stage by methanogens [6].

When simple organic compounds are broken down under anaerobic conditions, CO_2 and CH_4 are produced. Where CH_4

is produced so quickly that it cannot escape by diffusion, bubbles will form and pass-through overlying substrate and oxidation will not occur. This may occur in liquid manure systems where oxygen is scarce, but crusts present on liquid manure may slow the diffusion of gases and allow some oxidation [47] and also longer the manure is stored, the more CH_4 is produced. Manure from the dairy sector is managed in liquid systems that produce greater quantities of CH_4 emissions formed.

Mathematical models allow predicting CH_4 production from cattle without undertaking extensive and costly experiments. The models used can be classified as either statistical models, or dynamic mechanistic models. Statistical model, which relate nutrient intake to CH_4 production directly, dynamic model that estimate CH_4 production using mathematical descriptions of rumen fermentation biochemistry [31]. Methane is produced as a by-product of digestion of structural carbohydrates, due to the action of rumen microbes (bacteria, fungi and protozoa). During this digestion, monosaccharides are fermented to H_2 , CO_2 and Volatile Fatty Acids (VFAs), and as part of this stage of ruminant digestion some of the microbes (methanogens) produce CH_4 .

2.6. Accumulation of Methane Gas in the Environment

Methane gases accumulate in environment at favorable freezing rates for cryogenic displacement of methane accumulation. Such conditions were found in refrozen thaw bulbs and under the active layer zone without evidence of higher substrate concentration or a favorable environment for microbial Methanogens the zones of high methane concentration accumulated must have specific conditions for the preservation of methane gas [60]. However, according to it, the freezing front displaced methane from the thawed soil when permafrost developed. It formed accumulations of methane gas in environment and in some cases the gas-hydrate in lithological rock represented by coarse-grained soils or other highly porous media, surrounded by less permeable soils (including permafrost). Similar processes of cryogenic displacement and accumulation of substances like oil contaminants or salt ions were reported earlier methane accumulation [60]. High methane fluxes accumulate observed in the places of permafrost degradation under thermos karst lakes; seawaters or the mechanical disturbance of permafrost deposits is not always associated with increased organic matter decomposition or fault/ fracture zones. Methane concentration formation such accumulations depend on favorable conditions for methanogens. Especially in thaw bulbs, well pit, pump water, ground water, could create the gas-with increasing pressure and continuous methane formation [2].

2.7. Impact of Methane on Global Warming

The major impact of methane gas that causes severe global

warming in the atmosphere. Global warming becomes main issue in economics in the 21st century. Because global climate change becomes more dangerous and every nation realized due to greenhouse gas emissions accumulation effect. It is severe dangerous greenhouse gas, more global warming potential than carbon dioxide. Due to global warming the ocean levels are increasing, as a result, most of the coastal areas will submerge and some insects and animals will extinct [35]. Moreover, its effects on climate changes and atmospheric, is emitted from a variety of sources and its concentration in atmosphere has increased over the last few centuries.

One of the climate change gases, warming of earth surface is achieved by solar energy being radiated and increased global temperature concern with global environment [40]. Moreover, the gas could allow shortwave radiations to pass through the earth's atmosphere and heat the land and oceans. The long wave radiation emitted from earth surface cannot pass through atmosphere due to these greenhouse gases. Vehicular and industrial pollution is main contributor to the greenhouse gas effect and global warming [54].

2.8. Impact of Methane in Developing and Developed Nation

Major impact of methane in developing countries are characterized by low production per animal, low feed quality, climate change, environment pollution and, consequently, high emission intensity, cause global warming, the emission of methane increases temperature of the earth, Loss of land area, including beaches and wetlands [48]. Methane gas emissions which per unit of milk produced decrease in various countries, and identified large differences in developing regions such as, In sub-Saharan Africa, South Asia, and Near East and North Africa [46].

The emission intensity of dairy cattle in developing countries increase taking into account the limited economic and technical resources in most developing countries, developing countries produce a large quantity of those emissions, caused mainly by inefficient animal rearing systems, feed production and manure management [16]. Droughts and large-scale floods had a significant impact on the economy of developing countries where as increased air conditioning costs, Health damage and deaths from heat waves and spread of tropical diseases, Loss of agricultural output due to drought During these flood government incomes are often reduced due to a lower productivity while to increase the supply food aid and repair damaged infrastructure. In developing countries, the total CH_4 emissions impact will increase in future, mainly because of the expected rise in the number of livestock. The measure of how much heat methane gases could trap in the atmosphere in 100 years is named Global Warming Potential. These gases have high capacity to reflect infrared radiation back to earth, increase temperature on earth [27]. CH_4 emissions impact in developed nation directly from animals is not always feasible owing to high costs and need for expensive infrastructure such

as respiration chambers. When the costs of genomic selection will be more affordable for breeding organizations in transition economies [38].

The impact of methane in industrialized or developed countries, the situation is the opposite of developing countries, because productivity per animal has increased constantly in the last 30 years, owing to continues improvement in breeding, feeding, low emission intensity, high feed quantity and manage and the number of dairy cattle is decreasing and its increase the global atmospheric concentration between pre-industrial times and in 2005 from approximately 0.715 parts per million (ppm) to 1.774 ppm [11].

The major greenhouse gases associated with dairy production include methane (CH_4), carbon dioxide (CO_2), and nitrous oxide (N_2O). At the farm-gate level, average greenhouse-gas emission intensities were estimated at 7.5, 4.6, and 3.7 kg CO_2 -eq/kg fat- and protein-corrected milk (FPCM) in Sub-Saharan Africa, North Africa, and the Near East, respectively [17]. During enteric fermentation, microorganisms in the rumen break down carbohydrates and produce hydrogen (H_2) and carbon dioxide (CO_2). Methanogenic archaea utilize these substrates to produce methane (CH_4), which is released primarily through eructation (belching) [3].

2.9. Methane Accumulation Mitigation in Dairy Farm

Many strategies have been devised in attempts to develop methods used to mitigate CH_4 production, and these can be broadly categorized into three main methods, 1) nutritional or feed management, 2) modification of the rumen environment to directly inhibit methanogens, and 3) management practices that increase animal productivity [33].

2.9.1. Nutritional or Feed Management

This method represents the greatest amount of research conducted. This includes changing the quality of the feed, particularly the forage, or altering the forage-to-concentrate ratio to increase feed efficiency, shifting the site of digestion from the rumen to the intestines [6], inclusion of rumen modifiers designed to control or inhibit methanogenesis, and even immunization and defaunation [33]. If the aim is to improve nutrient utilization while increasing production of the animal, improvement in animal genetics may represent an important method to do so. Nutritional Techniques Fiber digestion, Fiber digestion increases CH_4 production due to increased production of acetate and H_2 by fibrolytic bacteria. A method to avoid this phenomenon is to manipulate the rumen and promote the growth of non- H_2 -producing fibrolytic bacteria such as *Fibrobacter succinogenes* [42]. With reduced H_2 concentrations, there would be a reduction in CH_4 production because the partial pressure in the rumen would remain lower. 46 Forage-to-concentrate ratios. Addition of concentrate in the diet is also an effective way to reduce CH_4 production. This is because fibrolytic bacteria are less active and become less important in

digestion of energy sources. A diet with greater concentrate inclusion may increase production due to an increase in available energy.

With increased concentrate or carbohydrate in the diet, there may also be a change in the rumen microbiota as well as rumen pH [23]. The reduction in CH_4 production would occur as the fermentation substrate changes from a fiber source to a starch source and more propionate-producing bacteria would thrive [6]. The production of propionate utilizes hydrogens, which would reduce the partial pressure and CH_4 production. Methane reduction will likely occur when concentrate is fed at concentrations greater than 40% of dietary dry matter [22]. In mid-to late lactation Holstein-Friesian cattle increased the starch concentration from 10 to 20% of dry matter and observed an 8% decrease in CH_4 production [19]. A limitation with increasing the concentrate in the diet is the potential to negatively affect milk quality that can occur when too much grain is fed. Increased starch or concentrate in the diet can decrease pH and inhibit fermentation of fiber, which ultimately leads to a decrease in milk quality. With increased starch concentrations [19] observed no negative effects on milk quality or rumen pH, demonstrating that with precise nutrition programs, maximum efficiencies may be achieved without negative impacts on the animal. Alternative H_2 sinks. Bacteria in the rumen can respire anaerobically and are capable of using alternative electron acceptors besides CO_2 to oxidize H_2 [42]. Nitrate. Nitrate may compete with methanogenesis for available hydrogens and reduce CH_4 production [45]. Nitrate-reducing bacteria have the capability to utilize hydrogens in the conversion of nitrate to nitrite and then to ammonia. This process is more thermodynamically favorable than methanogenesis [42]. Eight electrons are consumed during the reduction of nitrate to ammonia, which should lower production of CH_4 by one mol and should yield more energy [58]. Lipid supplementation and biohydrogenation are also used to reduce methane production Biohydrogenation represents additional hydrogen sink in the rumen. Unsaturated fatty acids have the potential to be biohydrogenated in the rumen and use hydrogens that become available when the double bonds are broken [6]. The process of biohydrogenation of fat may serve to utilize hydrogen in the rumen and potentially compete with methanogens in the rumen [28]. Early research with linolenic acid supplementation in sheep observed nearly complete biohydrogenation of unsaturated fatty acids in the rumen [14]. With the biohydrogenation, there was a decrease in CH_4 production. The degree of saturation for fatty acids may increase the amount of biohydrogenation and decrease CH_4 production by reducing H_2 concentration. [6] investigated the effects changing fat source to manipulate fatty acid profile by including crushed sunflower, flax, or canola seeds on CH_4 production in lactating dairy cows. The control ration was high in C16: 0 and C18: 1, the sunflower ration was high in C18: 1 (70.1 g/100 g of FA), the flaxseed ration was high in C18: 3, and the canola ration was high in C18: 1 and moderately high in 18: 2 Compared to a zero control, diets containing sunflower, flaxseed,

and canola meal all reduced CH₄, but were not different from one another (293, 264, 241, and 265 g/d for control, sunflower, flaxseed, and canola, respectively). One potential reason for no significant difference being observed among the different unsaturated FA rations could be the amount of FA in the diet. Lipid supplementation is another method used to reduce CH₄ production. production up to 40% depending upon the inclusion level in the diet, but reductions of 10 – 25% are more likely [6]. Methane may be reduced by 10 to 20% when 2 to 4% fat is added to the diet [6]. Fat concentration, fat content in the diet has the potential to affect CH₄ production. In a meta-analysis, [6] found that for every 1% increase in dietary fat, there is a 5.6% reduction in CH₄. When feeding coconut oil to weathers at either 3.5 or 7% of dietary dry matter [36]. Another best option measure to reduce methane accumulation emissions in dairy farm using nitrates to replace urea as a non-protein nitrogen source in the diet to meet the microbial requirements for rumen-degradable nitrogen, reduce emission from firewood and animal waste combustion. Adding sulphate to the diet of cow has been reduce CH₄ emission production [58].

To reduce methane emissions from manure, the focus has been on changing the characteristics of the manure to reduce the degradation of solids or designing manure systems to contain or capture emissions. Some strategies include Sources of methane emissions. composting, manure separation, manure storage covers and capturing methane from manure using anaerobic digestion systems to combust and convert the methane to carbon dioxide. For example, [1] found that GHG emissions from manure management can be reduced by nearly 50% with the installation of an anaerobic digester without even considering the benefits of replacing grid electricity. Therefore, the efficiency of the animal digests feed is increased, the amount of methane gas by rumen can be reduced [20].

2.9.2. Rumen Modifiers

Rumen modifiers affect the microbial community and alter the production of CH₄. For example, monensin is an ionophore commonly used to alter the microbial community and the production of volatile fatty acids, which has been illustrated to reduce CH₄ production [44]. Concerns have arisen with the potential benefits of long-term use of monensin on reducing CH₄ production. There is potential for different microbes to emerge when specific members of the communities are suppressed. However, [44] sustained a 7% decrease in CH₄ production during a 6-month study using monensin [4] observed a greater effect of monensin with beef steers compared to dairy cattle.

2.9.3. Management

Management decisions have one of the greatest impacts on CH₄ production. Forage type, genetics, culling, disease reduction, and facility type and design are all management decisions that affect CH₄ production [33]. Feed management may increase the productivity of the animal so they make more milk

per unit of feed intake and reduce CH₄ production [55]. Generally, When the fiber content of the diet increases CH₄ production is increased, whereas an increase in protein content of the diet leads to a decrease in CH₄ production [28, 55].

3. Conclusion and Recommendation

3.1. Conclusion

In general, methane is a powerful greenhouse gas that through the ozone layer back to the earth and raise the temperature. It affects the earth's radioactive balance by being oxidized to CO. It is also important for the atmospheric chemistry since it controls the abundance of Ozone and the Hydroxyl radical (which in turn affects the lifetime of other greenhouse gases, CH₄ emissions from livestock and mitigation actions in developing countries. The results indicate that emission intensities from livestock are medium to high in poor countries owing to low animal productivity, low feed quality, lack of knowledge, and limited investments. There are differences among developing countries in animal gas emissions in the same continent or region, indicating that improvements are possible.

The emissions of CH₄ from animal-producing farms normally result in a net GHG emission. The actual rate of methane and net GHG emission are highly dependent on the management strategies implemented on a farm. Lactating dairy cattle produce approximately 500 L of CH₄ daily, and CH₄ is 25 times more potent as a greenhouse gas compared to CO₂. Consequently, mitigation of CH₄ production has been a topic of increasing scientific interest. Methane production also represents a 2 to 12% energetic loss to the animal. Methane is produced during the formation of volatile fatty acids during fermentation. It is produced in response to an excess of hydrogen and a need to keep the partial pressure low and ultimately to maintain normal rumen fermentation. Fiber digestion increases acetate production, which due to the availability of hydrogens, increases CH₄ production. A linear relationship also exists between feed intake and CH₄ production. As cattle consume more feed, there is an increase in CH₄ produced. All of the important factors and measure the relevant sources of pollution in order to determine the overall environmental impact of farm production systems. This emphasizes the need for a whole farm for evaluating mitigation strategies in farm production systems.

3.2. Recommendation

Therefore, based on above conclusion the following recommendations are forwarded:

Methane emission should be controlled by improving feeding systems and management in dairy farms.

There should be provision of knowledge about methane emission for farmers and all farm managers.

Methane reduction strategies should be implemented in

dairy farms to contribute to methane gas emission reduction.

There should be adoption of new technology which decrease or prevent methane gas Accumulation from dairy farms.

Abbreviations

BWG	Body Weight Gain
CH ₄	Methane
CO ₂	Carbon Dioxide
DMI	Dry Mather Intake
GHG	Green House Gas
H ₂	Hydrogen
Kg	Kilogram

Author Contributions

Mebratu Mesfin: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology

Ediris Abdulkadir: Conceptualization, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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