UNIT 1 LIVESTOCK AND POLLUTION

Structure

1.0 INTRODUCTION

When you go around the villages, you might have seen that most of the households rear one or the other livestock. Can you guess what might be the reason behind this? Yes. Livestock is one of the important sources of income, employment, energy/transport and nutrition leading to nutritional and livelihood security to the rural masses. Livestock sector has immense contribution to the food security of the country by providing various highly nutritious products like milk, meat, egg etc. Since time immemorial, livestock rearing is a vital part of Indian agriculture helping in socio-economic development of more than two-thirds of the rural population in India. Livestock rearing is the lifeline for most of the farming community in the country and has both advantages and disadvantages. Can you enlist the different advantages of rearing livestock? The advantages are source of income, employment generation, supply of nutritious food and also acts as an easy source of mobile cash (also known as bank on hooves) especially at difficult times. Since, the activities are not dependent on season or rain as in the case of agriculture, farm animals/birds can be reared throughout the year. Livestock farming, particularly dairy farming (Fig. 1.1), also contributes significantly to enriching the soil with vital nutrients like NPK (Nitrogen-Phosphorus-Potash) from farm yard manure which are essential for the agriculture operations. At the same time, the livestock sector contributes significantly to several environmental problems like land degradation, air and water pollution, water shortage, loss of biodiversity, and ultimately to global warming. This unit will throw light on the contributions of

Livestock in Green House Gases Emission and its effects on environment and human health.

Fig.1.1: Dairy Farming

1.1 OBJECTIVES

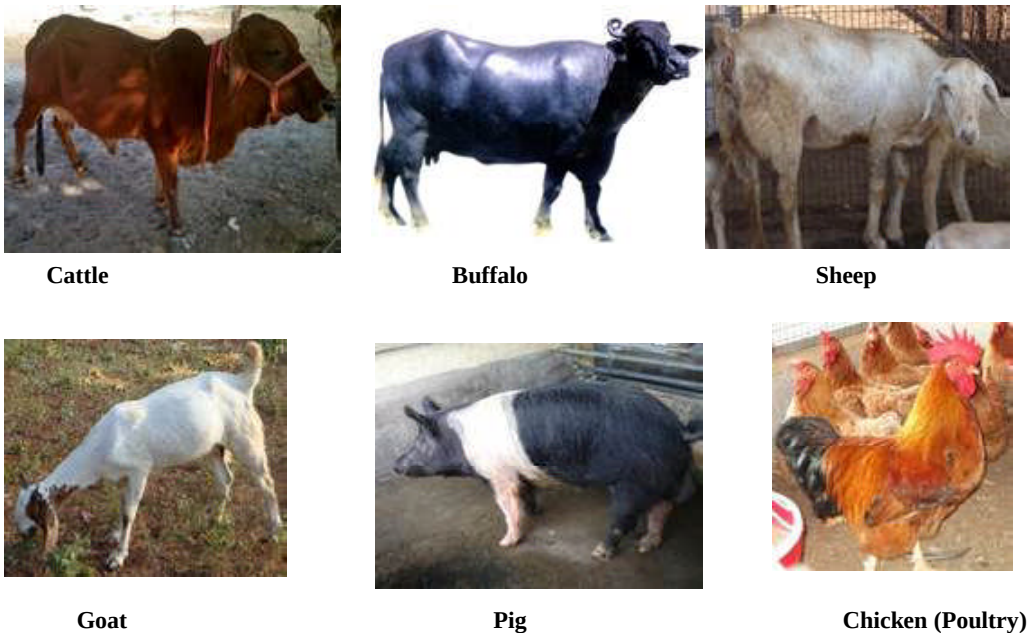
After studying this unit, you will be able to:

- Justify the role of livestock industry in livelihood security of farming community;
- Relate livestock population and the quantity of wastes generated from farm animals;
- Explain the role of livestock in greenhouse gas emission; and
- Describe the effects of livestock rearing on environment and human health

1.2 INDIAN LIVESTOCK INDUSTRY

Livestock sector includes animal husbandry, dairying and fisheries. Livestock industry is one of the fastest growing sectors of the agricultural economy and the share of Gross Value Added of livestock sector in terms of Agriculture (Crops & Livestock) is about 28.5% at Current prices and about 4% to the national economy during 2015-16. According to NSS 68th Round (July 2011-June 2012) survey on Employment and Unemployment, 16.44 million workers were engaged in farming of animals, mixed farming, fishing and aquaculture (DADF, 2017). Livestock contributed 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to two-third of rural community. It also provides employment to about 8.8 % of the population in India.

India is rich in livestock resources (Fig. 1.2) and the indigenous/desi breeds of different species of livestock are acclimatized to the local environmental conditions. Though their productivity is low, they are hardy and resistant to diseases. According to 19th Livestock Census (2012), India possess 190.9 million cattle, 105.3 million buffaloes, 65.07 million sheep, 135.2 million goat, 10.3 million pigs and 1.48 million other livestock species (DADF, 2014).



Cattle Buffalo Sheep

Goat Pig Chicken (Poultry)

Fig. 1.2: Livestock Resources in India

According to DADF (2017) the production statistics are presented below:

- **Milk:** It is one of the essential food items of human beings which provide sufficient nutritional supplements especially to the children and elder people. India has firmly established itself as the largest producer of milk in the world. The milk production and per capita availability of milk during 2015-16 is 155.5 million metric tonnes and 337 gm per day, respectively. About 49% of milk production is contributed by Buffaloes followed by 27%, 21% and 3% from Cow Exotic/Crossbred, Cow Indigenous/Non-Descript and Goats, respectively.
- **Egg:** It is one of the nutritious foods and a rich source of animal protein. The total egg production in the country was 82.93 billion numbers (8293 crores) and the per capita availability was 66 eggs per annum during 2015-16. About 82.99% of the egg production is contributed by Improved Fowl and 14.40% is from Desi Fowls. The Desi Duck and Improved Duck contributed 2.46% and 0.14%, respectively with respect to total egg production.
- **Meat:** The total meat production in the country was reported as 7.0 million tonnes (70 lakhs) during the year 2015-16. Poultry is the largest contributor of meat in the country (46%) followed by Buffalo (23%) and Goat (13%). The largest producer of meat is Uttar Pradesh which produces 19.59 % of the total meat production in the country followed by Andhra Pradesh including Telangana (14.99%) and West Bengal (10.41%).

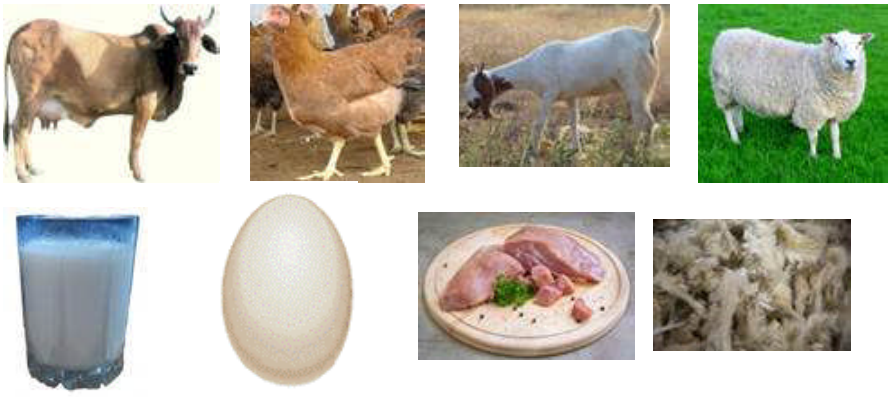


Fig. 1.3: Animal Based Products

- **Wool:** The total wool production in the country was at 27.5 million kg during 1950-51 and has shown a growing trend over the years. Currently, our country produces about 43.6 million kg (436 lakhs) during 2015-16. Nearly two-third (72%) of the wool production comes from Ram/Weather (Male Sheep/Goat) followed by Ewe and Lamb contributing only 24% and 4%, respectively. Rajasthan is the largest producer of wool in the country followed by Jammu & Kashmir and Karnataka.

Note: The livestock census is conducted by Department of Animal Husbandry Dairying & Fisheries (DADF), Ministry of Agriculture and Farmer's Welfare, Govt. of India every five years (Quinquennial). The Basic Animal Husbandry Statistics and the Annual Reports are released by DADF every year. Therefore, for latest data on livestock and production statistics, kindly visit DADF website (http://dahd.nic.in/).

Check Your Progress 1

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) India is rich in livestock resources – Justify the statement.

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2) _____ is the largest contributor of meat in the country.

3) Two-third of the milk production in India comes from Buffaloes. TRUE/FALSE

4) Livestock census is conducted by Department of Animal Husbandry Dairying & Fisheries (DADF), Ministry of Agriculture and Farmer's Welfare, Govt. of India every ____ years.

1.3 FARM ANIMAL WASTE

Every enterprise generates wastes. Similarly, dairy/livestock farm also generates different type of wastes. Can you classify the different types of waste we get from a dairy farm? The dairy/livestock farm waste can be classified into two - organic waste and inorganic waste. As the name suggests, the organic wastes include dung/faeces, urine of animals, droppings of poultry birds, leftover feed/

fodder, Wash water from cleaning of sheds and animals etc. While, the inorganic wastes include plastic bags, chemicals etc. However, in this section, we will focus mainly on the organic wastes with major emphasis on dung and urine. You might think that urine and dung are waste products of livestock. But, actually they are not waste, if utilized properly. Though we call the dung/urine as waste, they are highly nutrient-rich products obtained from the animals/ birds which can be directly used as manure or can be converted into compost/ vermicompost and used in agricultural fields.

1.3.1 Characteristics and Composition of Animal Wastes

Do you know what the beneficial characteristics of animal waste are? Animal waste is a rich source of many valuable nutrients which when recycled properly, can be efficiently used as fertilizer for crops/fodder production as well as to produce energy (biogas). Manure generated from animal waste is organic in nature and is rich in main nutrients required for soil health *viz.* Nitrogen (N), Phosphorus (P) and Potassium (K). In addition to providing essential nutrients for crop growth, manure has several other beneficial effects on soil properties. When the organic animal wastes are applied to the soil, the bulk density of the soil decreases as a result of increase in both the organic fraction of the soil and the stability of aggregates. Organic wastes like dung/faeces and urine also improves water filtration rate, water holding capacity and the hydraulic conductivity of the soil. All these properties of animal waste can be efficiently utilized only if they are properly recycled and managed. In turn, they might cause detrimental effects on the environment if not handled effectively and efficiently.

Can you guess how much animal waste is generated from different livestock species? It is estimated that the amount of dung/animal waste produced by different species of livestock are 4.5 kg/day from swine (liquid manure) and 45-50 kg/day from dairy cow (liquid).

However, the solid portion amounts to only 13-15% of the total volume. Normally, solid manure remains solid with less moisture. However, due to poor drainage, high humidity, rainwater entering the sheds and urine from animals, they may become semi-solid. The quantity and nature of animal waste also depend upon the species and age of the animals as well as the type of bedding material and feed. If you further look into the composition of animal waste, the Nitrogen: Phosphorus (N:P) ratio is different for different types of manure. It is 2:1 in case of cow whereas, it is reverse in case of poultry (1:2). In Pigs (swine), it is 1.5:1. The composition of cow dung (solid) is given in Table 1.1:

Table 1.1: Composition of solid cow dung

Parameters	Composition (in per cent)
Moisture	77.00
Organic Matter	20.00
Nitrogen	0.32
Phosphorus	0.14
Potassium	0.30
Calcium	0.40

1.3.2 Production, Collection and Management of Animal Wastes

Can anyone guess the value of cattle dung? The value of cattle dung is very high as it can be utilized as manure/fertilizer as well as production of cooking gas. You will be surprised to know that even an old bullock gives 5 tonnes of dung and 1,500 kg of urine in a year, which can help in the manufacture of 20 cart-loads of compost manure. For cultivation of cereal crops like sorghum and jowar on dry land, 5 carts of compost manure is required for each acre. Thus, the compost manure provided by one single old bullock can meet the manure need for 4 acres of land.

Do you know how we calculate the quantity of animal waste produced? Generally, it is calculated based on a measure called "animal unit." One animal unit is equivalent to 1,000 pounds i.e. 454 kg of the live weight of an animal. So what will be the animal unit of 4 dairy cows weighing 500 kg each? Right, it will be 4.4 animal units (500*4/454). Similarly, about 300 broiler chicken weighing 1.5 kg will be equivalent to one animal unit of chicken. It is estimated that one animal unit of broiler (meat) chicken produces an average of 14.97 tonnes of manure each year, whereas, one animal unit of dairy cows produces about 15.24 tonnes of manure per year.

Have you ever observed how the farm animal wastes are collected and managed? In our country, animal wastes (especially dung and urine) are usually collected manually (Fig. 1.4) in two ways. One is by collecting the dung and urine separately and the other method is by flushing dung and urine together. However, collection of solid waste and liquid waste separately is more helpful in efficient treatment and disposal of farm waste. It is a common practice in villages or small farms where the animal waste collected are dumped into heaps adjacent to the sheds. The heaps slowly get converted into farm yard manure which is subsequently used in the agricultural fields. Whereas, in commercial dairy farms, solid wastes (dung, leftover feed etc.) are usually collected and removed twice daily with the help of spade with long handle. The waste is scraped, collected and loaded into wheelbarrows, cart or trolley and transported to the manure pit. The liquid waste (urine and other wash waters) are collected through the drainage system.

Fig. 1.4: Dung collection

Fig. 1.5. Biogas plant

Fig. 1.6: Vermicompost

Now, next question which comes to our mind is how these animal wastes are managed or recycled? In India, farm animal wastes are managed or recycled in three ways. They are converted into farm yard manure (FYM) and used as organic fertilizer. In villages, the dung is converted into small cakes and used as fuel for cooking. The more recent methods being adopted by farmers and

commercial dairy/livestock farms include establishment of biogas plant and composting/vermicomposting units which is gradually getting popular. In biogas plant (Fig. 1.5), the animal wastes are digested under anaerobic (lack of oxygen) condition leading to production of methane gas which is used for cooking and the leftover slurry is used as farm manure. Whereas, in vermicomposting, the animal waste are digested using earthworms leading to production of nutrient-rich "vermicast/vermicompost" (Fig. 1.6).

Check Your Progress 2

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) What are the different types of wastes generated from livestock/dairy farm?

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2) How manure can be helpful in restoring the soil health?

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3) One animal unit is equivalent to _____ pounds or _____kg.

4) How the solid and liquid wastes are collected in a commercial dairy farm?

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5) In vermicomposting, the animal wastes are digested under anaerobic (lack of oxygen) condition leading to production of methane gas. TRUE/FALSE

1.4 LIVESTOCK AND GREEN HOUSE GASES EMISSION

Can you define green house gases? Green House Gases (GHGs) are group of gases present in the air which traps, absorbs and emits heat (radiation) in the atmosphere keeping the earth's surface warmer than it would be if they were not present. They include Water-vapour (H_2O), Carbon-dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Ozone (O_3) and Fluorinated gases like Chlorofluorocarbons (CFCs), Hydrofluorocarbons, Sulfur-hexafluoride etc. Under normal circumstances, the major proportions of the gases present in the atmosphere/air i.e. Nitrogen (N), Oxygen (O_2), Argon (Ar) etc. which constitutes about 96-99% of the atmosphere does not absorb or emit infrared radiation. Whereas, the remaining constituents of the air (1-4%) like the water-vapour, carbon-dioxide (CO_2) along with some other trace gases (about 0.05%) are responsible for the atmosphere pollution and green house effect (Dessler and

Parson, 2009). Each and every living creature produces greenhouse gases in some way or the other. In addition to this, these gases are also produced in nature and also through human interventions like industry, agriculture operations, livestock rearing etc.

1.4.1 GHGs from Livestock

We normally believe that animal wastes like dung, urine etc. are harmless. But in reality, they can be quite hazardous. Commercial/industrial livestock farms pollute the air by releasing different types of harmful gases, mainly due to production of large quantities of manure. These gases are dangerous air pollutants and threaten both the environment and human health. The predominant gases produced by the livestock are as follows:

a) Carbon-dioxide (CO_2): Livestock sector is responsible for emission of carbon-dioxide directly through feed and livestock products production, processing and transport; livestock respiration and indirectly through expansion of land for pasture and crop or feed production. Worldwide, ruminant species like cows, sheep, goat etc. emit about two billion metric tonnes of CO_2-equivalents per year. In general, livestock respiration is not counted as a net source of CO_2 emission because they are considered as part of the global biological system cycle. However, carbon-dioxide (unaccounted) from livestock respiration accounts for 21 per cent of anthropogenic GHGs worldwide which works out to about 8,769 million tonnes according to an estimate by British physicist Alan Calverd during 2005 (Goodland and Anhang, 2009). In addition, clearing of forests in order to get more grazing land and farm land also contribute for an extra 2.8 billion metric tonnes of CO_2 emission per year.

b) Methane (CH_4): Livestock, especially the ruminants, are the largest source of methane emitter in the world. Non-ruminant species like pigs, horse etc. also produce CH_4 but the amount is much lower when compared to ruminants. The production of methane gas is mainly due to two processes *viz.* manure storage/recycling and enteric fermentation in the digestive tract of animals. During storage and recycling of animal waste, methane gas is produced under anaerobic condition through bio-degradation of organic materials i.e. dung, urine etc. when manure is managed in liquid form. The major contributors of methane gas amongst the livestock are the ruminant species like cow, sheep, goat etc. which are four-stomached animals when compared to the mono-gastric (single stomached) animals like pig, horse etc. This is due to the differences in the food habits and digestion process. During the process of digestion in the ruminant's stomach, food particles (carbohydrates) are broken down into simple nutrients through fermentation process in the presence of bacteria present in the rumen. This fermentation process also generates two by-products *viz.* carbon-dioxide and methane. Research studies reveal that the methane emissions from a single dairy cow amount to the equivalent of up to 1.5 metric tonnes of carbon-dioxide each year. Globally, this adds up to the equivalent of 2.2 billion tonnes of carbon-dioxide per year. If you compare the properties of methane and carbon-dioxide, methane has 21 times the heat-trapping power of carbon-dioxide over a 100-year period (FAO, 2006). On comparing the life span of these two gases, it was found that methane only stays in the atmosphere for about 9-15 years, whereas,

carbon-dioxide can remain for hundreds of years. However, if you take into account the greenhouse gas's ability to rapidly impact global warming, methane is considered to be far more dangerous.

c) ***Nitrous Oxide (N_2O):*** It is another potent greenhouse gas with a long lifetime of 150 years in the atmosphere and large radiative-forcing potential which is 310 times that of CO_2. Nitrous oxide emission from livestock sector is as a result of two major activities *viz.* manure management and feed production, processing and transport. They are also released in large quantities from dairy farms through application of manure and artificial fertilizers on fields and from ammonia losses during and after the growing season. Manure contains two chemical components that can lead to GHG emissions during storage and processing: organic matter that can be converted into CH_4, and Nitrogen that leads to N_2O emissions. During storage and processing, nitrogen is released in the atmosphere as ammonia (NH_3) that can be later transformed into N_2O (indirect emissions). The emissions of N_2O come from the use of fertilizers (organic or synthetic) for feed production and from the direct deposition of manure on pasture or during the management and application of manure on crop fields. Direct or indirect N_2O emissions can vary greatly according to temperature and humidity at the time of application and their quantification is thus subject to high uncertainty (Gerber *et al.*, 2013).

d) ***Other Gases:*** They include hydrogen sulfide, ammonia (NH_3) etc. During composting of the carcass, anaerobic microorganisms work to decompose it, releasing fluids and odourous gases such as hydrogen sulfide and ammonia. The livestock sector contributes to about 64 per cent of ammonia emission mostly from poultry sector, which contributes significantly to acid rain.

Check Your Progress 3

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Define GHGs?

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2) Match the following:

Column A	Column B
1. Carbon-dioxide	a. Enteric fermentation
2. Methane	b. Manure management
3. Nitrous oxide	c. Composting
4. Ammonia	d. Respiration

3) The major contributors of methane gas amongst the livestock are the ruminant species – Justify the statement.

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4) On comparing the life span of these two gases, it was found that methane only stays in the atmosphere for about _____ years.

1.4.2 Global and Indian Scenario

According to Steinfeld (2006), livestock related sources of green house gas emissions include enteric fermentation and respiration, animal manure, livestock related land use change, deforestation linked to livestock, livestock related release from cultivated soils, feed production, on-farm fossil fuel use and post-harvest emissions. Garnett (2007) states that livestock reared in extensive systems, such as ruminants, tend to have a lower per area footprint than those in intensive systems like poultry and pigs, but have a higher footprint when expressed in terms of per kg of product. Cattle produce the most greenhouse gas emission among ruminants followed by sheep, goats and buffaloes.

Since long, there has been debate over exactly how much the livestock industry contributes to climate change. Can you guess how much the livestock sector contributes to greenhouse emission in the world scenario? You will be astonished to know that in terms of the environment, it is well-known fact that livestock sector contributes for 14.5% (7.1 gigatonnes CO_2-eq per annum) of global human-induced (anthropogenic) greenhouse-gas emissions, surpassing that of the transportation (FAO, 2006). If you look into the sources of the GHG emission, feed production and processing and enteric fermentation from ruminants are the two main sources of emissions, representing 45 and 39 per cent of sector emissions, respectively. Manure storage and processing contributes only 10 per cent. The remainder is attributable to the processing and transportation of animal products (Gerber *et.al*., 2013). The highest total of livestock-related greenhouse-gas emissions comes from the developing countries like India, which accounts for about two-thirds of the global emissions from cattle and other ruminants and half of the global emissions from poultry and pigs. Livestock constituted 63.4% of the total GHG emissions from agriculture in India. The major reason for this condition might be due to the fact that systematic management of farm animal waste/manure is not commonly practised in India. The total GHGs emission from Indian livestock is estimated at 247.2 MT in terms of CO_2 equivalent emissions.

Now, let us turn our focus towards gas-wise and species-wise scenario:

- **Carbon-dioxide:** According to the FAO, when emissions from land use and land use changes are included, the livestock sector accounts for 9 per cent of CO_2 deriving from human-related activities. According to IPCC (2007), the entire livestock supply chains emits about 2 gigatonnes CO_2-eq of CO_2 per annum, or 5 per cent of anthropogenic CO_2 emissions. Cattle are the main contributor to the sector's emissions with about 4.6 gigatonnes CO_2-eq, representing 65 per cent of sector emissions. Pigs, poultry, buffaloes and small ruminants have much lower emission levels, with each representing between 7 and 10 per cent of sector emissions (Gerber *et.al.*, 2013).

- **Methane:** According to FAO report, cows contribute 44 per cent of methane production. The entire livestock supply chains emits 3.1 gigatonnes CO_2-eq of CH_4 per annum, or 44 per cent of anthropogenic CH_4 emissions (IPCC, 2007). Enteric methane emission from livestock

was the major source accounting 85.6% of total GHG from world livestock in year 2010 (Patra, 2014). Globally, Cattle emit most of the enteric methane (73.7%), followed by buffaloes (11.3%) and small ruminants (11.2%). As far as India is concerned, its livestock contributed 15.1% of total global enteric methane emission. Dairy buffalo and indigenous dairy cattle together contribute 60% of these methane emissions. Enteric fermentation constitutes about 91.8% of the total methane emissions from Indian livestock when compared to methane from manure management (7%). Bovines contribute a bulk of the methane emission from enteric fermentation i.e. cattle (49 %) and buffalo (42 %), followed by small ruminants like goat (5%) and sheep (3%), and negligible emission of 0.7 % from other categories. Although the Indian livestock contributes substantially to the methane budget, the per capita emission is only 24.23 kg CH_4 /animal/year (Chhabra *et. al.,* 2013).

Nitrous Oxide: According to IPCC (2007), the entire livestock supply chains emits about 2 gigatonnes CO_2-eq of N_2O per annum, or 53 per cent of anthropogenic N_2O emissions which has 296 times the Global Warming Potential (GWP) of CO_2. Globally, cattle (46.2%) accounted for the major share of N_2O emission, followed by swine (24.8%), poultry (15.4%) and buffalo (7.57%) and remaining other livestock species. India's contribution was only 4.0% of total global nitrous oxide emission from manure during 2010. Nitrous oxide emission was mostly contributed by buffalo (31.4%) and cattle (26.8%), goat (15.8%), poultry (15.0%) and sheep (7.8%) in India.

Check Your Progress 4

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) What are the livestock related sources of green house gas emissions?

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2) Livestock sector contributes for _____ % of global human-induced (anthropogenic) greenhouse-gas emissions.

3) List the major sources of GHGs emission from livestock sector.

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4) In India, dairy buffalo and indigenous dairy cattle together contribute 60% of _____ emission.

1.5 EFFECTS OF LIVESTOCK REARING ON ENVIRONMENT AND HUMAN HEALTH

Livestock production systems are intensifying worldwide, particularly in urban and peri-urban areas. In recent times, the livestock rearing has changed from extensive/mixed farming systems to specialized (commercial/industrial) dairy

farming with zero grazing under confinement and is termed as intensive livestock farming. Though this has resulted in improving the profitability, at the same time, it has also contributed significantly to the pollution of air, water and soil. The livestock waste which is a major source of harmful green house gases, pollution and harmful pathogens is emerging as a serious environmental and human health concern.

The effects of livestock include pollution (air, soil, water), propagation of flies and parasites, loss of biodiversity and occupational health hazards. Let us see the various effects of livestock rearing on environment and human health:

1.5.1 Environmental Health

The most common environment concern with animal wastes is that it affects the atmospheric air with offensive odours, release of large quantities of noxious gases like CO_2 CH_4, N_2O, ammonia etc. which might contribute to green house effect and acid rain. Being one of the largest populations and densities of both people and livestock in the world**,** India is already facing severe emission, water, land and hunger challenges. A growing problem with the massive number of cattle in India, is the amount of animal waste that is generated. This has resulted in the serious environmental concerns caused by the livestock industry, including carbon emissions, land & water usage changes and pollution. Additionally, continuous increase in the consumption of animal products in India is expected to be the driving force behind global increases in demand for meat and dairy over the coming decades. As production & consumption continues to grow, these environmental challenges are only going to worsen if India continues its current level of growth in animal production and consumption going forward. Now, let's turn our focus on the different impacts of the livestock farming on the environment:

i) Deforestation and land degradation

- The livestock sector is by far the single largest anthropogenic user of land. Expansion of livestock production is a key factor in deforestation. Livestock uses about two-third (70%) of all agricultural land and one-third (30%) of the earth's entire land surface, predominantly for permanent pasture. In addition, the total area dedicated to feed/fodder crop production amounts to about two-third (33%) of total global arable land. As forests are cleared to create new pastures, it is a major driver of deforestation.

- Deforestation to clear land for pastures, fodder extraction, expanding agricultural cultivation of crops in forests and on grazing lands and the widespread use of fertilisers to grow crops like maize and soyabean as livestock feed are all contributing to rising rates of land degradation and desertification in India. Hunger for land for both crops and livestock is also a primary cause of bio-diversity loss.

- Goats contribute significantly towards deforestation and soil erosion attributed to its feeding habit i.e. browsing. However, the goat's bad reputation arises mainly due to mismanagement by man rather than inherent fault.

- According to the Ministry of Agriculture, Government of India, the carrying capacity of Indian grasslands is about 0.20 to 1.47 adult cattle

units (ACU)/ha. Grazing intensity in the country is as high as 12.6 adult cattle units (ACU)/ha as against 0.8 ACU/ ha in developed countries and 1 ACU/ha allowed by Indian government norms. The quality and productivity of grazing lands are also showing a declining trend due to improper management, unregulated land use, overgrazing and lack of reseeding of pastures. It is argued that one of the reasons for deforestation is uncontrolled grazing of livestock in forest land. All these factors contribute to land degradation, particularly in the open grazing areas in the arid and semi-arid ecosystem.

- As far as land degradation is concerned, livestock causes wide-spread land degradation through overgrazing, compaction and erosion (FAO, 2006). This impact is even higher in the drylands where inappropriate policies and inadequate livestock management contribute to advancing desertification.

ii) Pollution (Soil, Air and Water)

- The IFPRI-FAO study conducted by Mehta *et al.* (2002) shows that there are bio-security issues associated with industrial poultry production in India such as polluted water, soil toxicity, wastage disposal and health hazards, especially when the production units are located too close to densely populated areas. Soil toxicity occurs due to build up of nitrogen and phosphorus in the soil deposited through manure over a period of time. Farms close to population centers and water bodies produce ecological harm due to over concentration of nutrients and human health issues.
- Biodegrading livestock waste also emits odorous gases that contain as many as 60 compounds like ammonia and amines, sulphides, volatile fatty acids, alcohols, aldehydes etc. (Sweeten, 1995).
- The livestock industry contributes significantly to depletion of water resources and water pollution. The major water polluting agents are animal wastes, medicines, chemicals from tanneries, fertilizers and the pesticides used to spraying crops produced for livestock. In addition, widespread overgrazing disturbs water cycles, reducing replenishment of ground water resources and utilization of water towards the production of feed and fodder.
- Animals can negatively affect water quality by having free access to water sources where they are able to deposit waste and cause the water to become cloudy from stirring up mud. Water contamination can occur in many different ways. In extensive systems, livestock often have access to bodies of water where they are able to deposit waste. This waste travels downstream and has direct contact with humans. In intensive production systems, bacteria can enter water sources during heavy rainfalls that might result in an overflow of the manure catchment basin or from manure that has been put on fields as fertilizer.
- The animal wastes and its by-products intentionally or unintentionally enter rivers, streams, and groundwater. These organic and inorganic pollutants contribute to the contamination of an estimated 70 per cent of India's surface water and an increasing percentage of its groundwater.

iii) Hunger

- The increasing demand for grains to feed livestock will create pressure to cultivate (and/or import) feed grains, which will ultimately compete with grain production for human consumption. India produced about 24.17 million tonnes of maize during 2014-15, of which about 50% was used by the poultry sector.

iv) Loss of biodiversity

- Very high concentrations of nutrients like phosphorus and nitrogen released from the animal waste and storage structures cause a range of ecological problems like fish kills or a loss in biodiversity when released into the environment. Livestock farming depletes soil nutrients and pollutes the environment as waste runoff from farms causes algae blooms that consume oxygen in water, killing essential bacteria and destroying healthy ecosystems (Baur, 2015). Further, Nitrogen in water also contributes to increased algae blooms that reduce the oxygen availability to fishes.
- According to the Millennium Ecosystem Assessment (MEA), the most important drivers of biodiversity loss are habitat change, climate change, invasive alien species, overexploitation, and pollution. Livestock production and intensification contributes to all of these drivers. It is estimated that approximately 30 per cent of global biodiversity loss can be attributed to aspects of livestock production.
- Ten per cent of the world's plant and animal species that face some degree of threat are experiencing habitat loss based on livestock production (FAO, 2006).
- Of the world's thirty-five biodiversity hotspots, containing the highest levels of endemic species that have lost 70 per cent or more of their original habitat, twenty-three are affected by livestock production.

Check Your Progress 4

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Which changes in the livestock sector have contributed significantly to the environmental pollution in recent times?

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2) List the different impacts of the livestock farming on the environment.

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3) _____ contributes significantly towards deforestation and soil erosion attributed to its feeding habit.

4) What are the most important drivers of biodiversity loss?

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1.5.2 Human Health

Rearing of livestock may affect the human health through physical, chemical and biological hazards. When a person handling the animals becomes sick or gets hurt due to contact with animals and its wastes, it is termed as Occupational Health hazard. In other words, an occupational hazard is a hazard experienced in the workplace. Let us see the impact of livestock on human health:

i) **Physical Hazards:** Labour working in the livestock farm and handling livestock especially large animals may get injured due to stepping on, crushing, kicking and biting by the animals. It is established beyond doubt that high dust exposure in animal/poultry confinement buildings is a respiratory health hazards like chronic bronchitis, asthma-like symptoms like wheezing and shortnesss of breath during work.

ii) **Chemical Hazards:** Improper handling of solid animal waste is a serious health hazard especially for the workers who come in direct contact with the animal waste. According to the Environmental Protection Agency (EPA), drinking water contaminated with nitrate concentrations from animal waste/manure above ten parts per million (ppm), can cause developmental deficiencies in infants and death in severe cases due to oxygen deprivation. Nitrates introduced into the body through affected water significantly reduce the blood's oxygen carrying capacity, and deprive the body of oxygen. High nitrate concentrations are also believed to have caused spontaneous abortions and possibly cancer. In addition, some of the noxious gases generated by the animals/birds like methane, ammonia etc., when inhaled by the humans may result in nausea, headaches, breathing problems, sleep interruption, appetite loss and irritation of the eyes, ears and throat. Given the variety and extent of exposures related to livestock production, respiratory diseases may be the major health problem. Gases play an important role in causing lung disorders. In animal confinement buildings and facilities, ammonia levels often contribute to respiratory problems. Similarly, the gases in livestock facilities can also pose other risks to workers; for example, methane is highly flammable, and if not vented properly from manure tanks it can cause explosions. Acute poisoning from hydrogen sulphide gas released from manure storage facilities in dairy barns can cause fatalities.

iii) **Biological Hazards:** Livestock acts an important source of biological hazard. Over 150 zoonotic diseases have been identified worldwide, with approximately 40 significant for human health. The health consequences of zoonotic diseases range from the relatively benign flu-like symptoms of Brucellosis to debilitating Tuberculosis or potentially lethal strains of *Escherichia coli* or Rabies. The common zoonotic diseases are Anthrax, Brucellosis, Hydatidosis, Leptospirosis, Q fever, Rabies, Salmonellosis, Tuberculosis etc. The spread of zoonotic diseases may be through direct or indirect contact, vector-borne or food-borne.

Now, having learnt about the effects of livestock on environment and human health, do you know how we measure the impact of livestock on climate change? It is known by its carbon foot print. A carbon foot print is defined as the total amount of greenhouse gases produced directly and indirectly from the Livestock and is usually expressed in equivalent tonnes of carbon-dioxide. Emissions from livestock are measured either in terms of kg CO_2 equivalent per kg meat or milk produced or per hectare of land used. With increased prosperity, people are consuming more egg, meat and dairy products every year. Global meat production is projected to double from 229 million tonnes in 1999/2001 to 465 million tonnes in 2050, whereas, milk output is set to reach 1043 million tonnes. GHG emission could touch 2,930 million tonnes CO_2-eq in 2050 due to animal population growth driven by increased demands of meat and dairy products in the developing countries (Patra, 2014). But such rapid growth exacts a steep environmental price, according to the FAO Report (2006), Livestock's Long Shadow - Environmental Issues and Options. "The environmental costs per unit of livestock production must be cut by one half, just to avoid the level of damage worsening beyond its present level," it warns. This can be achieved by adhering to various strategies to mitigate or reduce greenhouse gas emissions in livestock farming like:

- **Augmenting the Production efficiency** of the animals by getting more output of meat, milk and eggs per unit input through improved feeding practices, breeding strategies, diversification etc.
- **Reducing enteric fermentation** through practices such as improvement of animal nutrition and genetics like increasing dietary fat, providing supplements etc.
- **Better manure management** by adopting to manure collection, storage (shortening storage duration), and disposal practices (improving timing/ application of manure) that not only reduce GHGs emissions, but also address the water and air quality concerns.
- **Improving the Energy efficiency** in the animal production system by shifting towards more energy efficient lighting, heating and cooling systems (Smith, 2014).
- **Adopting to Carbon Sequestration** (capturing and storing carbon in the soil) by maintaining cover crops, decreasing deforestation rates, replanting trees or other perennial vegetation for reversing deforestation, improvement in land and water management etc. (Patra, 2014)

Check Your Progress 6

Note: a) Write your answer in about 50 words.
b) Check your answers given at the end of this unit.

1) Define Occupational Health hazard?

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2) Gases in livestock facilities can also pose other risks to workers – Justify with an example.

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3) List the important zoonotic diseases.

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4) What are the various strategies to mitigate or reduce greenhouse gas emissions in livestock farming?

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1.6 LET US SUM UP

Livestock is one of the important sources of income, employment, energy/ transport and nutrition (milk, egg, meat etc.) to the rural masses. It contributes significantly to enriching the soil with vital nutrients like NPK from farm yard manure which are essential for the agriculture operations. Dairy/livestock farm generates both organic and inorganic wastes. Livestock farming generate important greenhouse gases like carbon-dioxide, methane, nitrous oxide etc. which threaten both the environment and human health. Livestock, especially the ruminants, are the largest source of methane emitter in the world. Livestock related sources of green house gas emissions include enteric fermentation and respiration, animal manure, livestock related land use change, deforestation linked to livestock, livestock related release from cultivated soils, feed production, on farm fossil fuel use and post harvest emissions. Livestock sector contributes for 14.5% of global anthropogenic greenhouse-gas emissions, surpassing that of the transportation. Livestock constituted 63.4% of the total GHG emissions from agriculture in India. Livestock sector contributes significantly to the many environmental problems like deforestation, land degradation, air, soil and water pollution, loss of biodiversity, and ultimately to global warming. Rearing of livestock may affect the human health through physical, chemical and biological hazards. According to the FAO Report (2006), "The environmental costs per unit of livestock production must be cut by one half, just to avoid the level of damage worsening beyond its present level".

1.7 KEY WORDS

Anthropogenic : Caused or produced by humans.

Browsing : To eat, nibble or feed on leaves, tender shoots or other soft vegetation

Carbon footprint	:	The total amount of GHG emissions associated with a product along its supply chain; usually expressed in kg or tonne of carbon-dioxide equivalent (CO_2-eq) per unit of output.
CO_2-eq emission	:	The amount of CO_2 emissions that would cause the same time-integrated radiative forcing, over a given time horizon, as an emitted amount of a mixture of GHGs. It is obtained by multiplying the emission of a GHG by its global warming potential (GWP) for the given time horizon.
Global Warming Potential (GWP)	:	Defined by the Intergovernmental Panel on Climate Change (IPCC) as an indicator that reflects the relative effect of a GHG in terms of climate change considering a fixed time period, such as 100 years, compared with the same mass of carbon-dioxide.
Greenhouse gas	:	Gases that trap heat in the atmosphere. eg. water vapour, CO_2, methane, nitrous oxide etc.
Hardy	:	Capable of enduring difficult conditions.
Inorganic Waste	:	These are non-biodegradable waste like chemicals of mineral origin, pesticides etc.
Livestock	:	Livestock are domesticated animals reared by human beings to produce commodities such as food, fiber, and labour. Eg. Cattle, Buffalo, Sheep, Goat etc.
Organic Waste	:	These are materials that are biodegradable and come from either a plant or animal like cow dung.
Zoonotic	:	A disease that can be transmitted from animals to people or, more specifically, a disease that normally exists in animals but that can infect humans.

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1.9 ANSWERS TO CHECK YOUR PROGRESS

Your answers should include the following points:

Answers to Check Your Progress 1

1. India is rich in livestock resources because it possess 190.9 million cattle, 105.3 million buffaloes, 65.07 million sheep, 135.2 million goat, 10.3 million pigs and 1.48 million other livestock species
2. Poultry
3. TRUE
4. Five

Answers to Check Your Progress 2

1. Different types of waste generated from a livestock/dairy farm can be classified into two - organic waste and inorganic waste. Organic wastes include dung/faeces, urine of animals, droppings of poultry birds, leftover feed/fodder, Wash water from cleaning of sheds and animals etc. While, the inorganic wastes include plastic bags, chemicals etc.
2. Manure is rich in main nutrients like Nitrogen, Phosphorus and Potassium. In addition to providing essential nutrients for crop growth, manure has several other beneficial effects on soil properties. When the organic animal wastes are applied to the soil, the bulk density of the soil decreases as a result of increase in both the organic fraction of the soil and the stability of aggregates. Organic wastes like dung/faeces and urine also improves water filtration rate, water holding capacity and the hydraulic conductivity of the soil.
3. 1000 pounds or 454 kgs.
4. Animal wastes are usually collected manually in two ways in a commercial dairy farm. One is by collecting the dung and urine separately and the other method is by flushing dung and urine together. Solid wastes (dung, leftover feed etc.) are usually collected and removed twice daily with the help of spade with long handle. The waste is scraped, collected and loaded into wheelbarrows, cart or trolley and transported to the manure pit. The liquid waste (urine and other wash waters) are collected through the drainage system.
5. FALSE

Answers to Check Your Progress 3

1. Green House Gases (GHGs) are group of gases present in the air which traps, absorbs and emits heat (radiation) in the atmosphere keeping the earth's surface warmer than it would be if they were not present. They include Water-vapour (H_2O), Carbon-dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Ozone (O_3) and Fluorinated gases like Chlorofluorocarbons (CFCs), Hydrofluorocarbons, Sulfur-hexafluoride etc.

2. 1-d, 2-a, 3-b, 4-c

3. The major contributors of methane gas amongst the livestock are the ruminant species like cow, sheep, goat etc. due to the differences in the food habits and digestion process. During the process of digestion in the ruminant's stomach, food particles are broken down into simple nutrients through fermentation process in the presence of bacteria present in the rumen. This fermentation process also generates two by-products *viz.* carbon-dioxide and methane.

4. 9-15

Answers to Check Your Progress 4

1. Livestock related sources of green house gas emissions include enteric fermentation and respiration, animal manure, livestock related land use change, deforestation linked to livestock, livestock related release from cultivated soils, feed production, on-farm fossil fuel use and post-harvest emissions.

2. 14.5%

3. Feed production and processing, enteric fermentation from ruminants and manure management

4. Enteric Methane

Answers to Check Your Progress 5

1. In recent times, the livestock rearing has changed from extensive/mixed farming systems to specialized (commercial/industrial) dairy farming with zero grazing under confinement and is termed as intensive livestock farming. Though this has resulted in improving the profitability, at the same time, it has also contributed significantly to the pollution of air, water and soil.

2. The different impacts of the livestock farming on the environment are deforestation and land degradation; soil, air and water pollution; loss of biodiversity; competition for food grains between humans and animals/ birds

3. Goats

4. According to the Millennium Ecosystem Assessment (MEA), the most important drivers of biodiversity loss are habitat change, climate change, invasive alien species, overexploitation, and pollution

Answers to Check Your Progress 6

1. When a person handling the animals becomes sick or gets hurt due to contact with animals and its wastes, it is termed as Occupational Health hazard. In other words, an occupational hazard is a hazard experienced in the workplace.

2. The gases in livestock facilities can also pose other risks to workers; for example, methane is highly flammable, and if not vented properly from manure tanks it can cause explosions; Acute poisoning from hydrogen sulphide gas released from manure storage facilities in dairy barns can cause fatalities.

3. Anthrax, Brucellosis, Hydatidosis, Leptospirosis, Q fever, Rabies, Salmonellosis, Tuberculosis.

4. Augmenting the Production efficiency of the animals, Reducing enteric fermentation, Better manure management, Improving the Energy efficiency in the animal production system and Adopting to Carbon Sequestration.