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Review Article

Swine Farming in Changing Climate Scenario: A Review

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Abstract

Among various livestock species swine farming is responsible for 9 per cent of Green House Gases emission globally, which is directly related to the global warming. The primary sources of Green House Gases emission in swine production system are feed production (48.0%) and manure (27.4%). The other contributing factors (24.6%) are enteric emission, housing systems, feeding practices, energy utilization and supply chain. Areas in which mitigation measures against Green House Gases emission can be taken are manure management, strategic feed production and nutrition supply, housing, adopting organic production system, providing easily palatable feed to reduce enteric fermentation and using genetically improved superior breeds to reduce the numbers of swine to be reared.

Keywords: Climate Change, Greenhouse Gases, Renewable Resources, Swine

Introduction

The issue of global warming due to climate change has accredited itself to occupy one of the topmost lists to be tackled in this century. The greenhouse gases (GHGs) are generally considered to be the primary indicators of global warming and the principal GHGs are carbon dioxide, methane, nitrous oxide and chlorofluorocarbons. After the energy sector, the livestock sector comes second with the maximum emission of methane and nitrous oxide (IPCC, 2014). The emissions from crop and livestock production grew from 4.7 billion tonnes of carbon dioxide equivalents (CO_2-eq.) in 2001 to over 5.3 billion tonnes in 2011, an increase of 14 per cent. CO_2-equivalent emission is the amount of CO_2 emissions over a given time horizon that cause the same time-integrated irradiative forcing, as an emitted amount of a mixture of GHGs. Among various meats, swine meat *i.e*. pork is the most widely eaten meat accounting for about 36 per cent of world meat intake. Globally, pork production is responsible for 668 million tonnes CO_2-equlivent emission; which are mostly occur from swine feed production chain (48.0%) and manure (27.4%). In feed production only soybean cultivation contributes 12.7 per cent and use of fertilizer together with transportation of feeds are responsible for 27 per cent emission. Post farming emissions from processing and transport contribute 5.7 per cent of total GHGs output (Gerber *et al.*, 2013). India, which ranks third after China and United States in GHGs emission, lags slightly behind in the piggery sector, but a slow yet steady momentum is expected to be gained in the coming years (Herrero *et al*., 2016). In North East India about 33 per cent of the pigs are crossbred, whilst most of the pigs are reared in backyard farming system with the number of pigs ranging from 1 to 3. There also seems to be a lacuna in other factors concerning pig rearing, such as availability of proper nutrition, artificial insemination for superior germplasm, proper housing, adequate health management, market facilities; which are directly related to the adverse effects on the environment (Deka, 2015). Hence, a review on below mentioned eco-friendly swine farming practices where mitigation measures can be taken to reduce GHGs emission is the need of the hour.

1. Manure Management

The improper manure disposal in piggery units is a major factor in GHGs emission. The global methane emission due to decomposition of manure has been estimated to be around 10 million tonnes or about 4.0 per cent of the total anthropogenic emission. Though this figure is smaller than methane emission due to enteric fermentation, yet it surpluses emission due to rice cultivation or residue burning. The lions share in this sector is contributed by pigs, almost half of the total manure related emission globally. India recorded an increase in manure related methane emission from 0.52 million tonnes (1960) to 1.10 million tonnes (2010). The maximum emission was due to buffalo, followed by cattle and pigs, whereas highest annual growth was recorded for poultry (4.28%), which was higher than the world average (Patra, 2014). In comparison to methane, nitrous oxide from improper manure management contributed a small amount to the total GHGs emissions. The global picture revealed cattle contribute the major share (46.20%), followed by swine (24.80%), poultry (15.40%) and buffalo (7.57%) and rest from other species of livestock (Gerber *et al*., 2005, EPA, 2011, Steinfeld *et al*., 2006 and Patra, 2014).

The form of manure produced from swine differs in different housing systems. Conventional housing system produces more of liquid effluent, deep litter housing produces spent bedding and in outdoor manure is the primary by-product. The proper management of manure demands collection of effluent, pre-treatment and waste water treatment (Opio *et al*., 2013).

Collection: The most common ways for collection of manure include drains, flushing channels, static pits and pull plug pits or scrapers (Hamilton, 2010). Some older farms use static pits that store manure for about two weeks and then release it, resulting in increased emission of GHGs.

Pre-treatment: In some farms, separation of solids from effluent is performed to reduce accumulation of sludge. Some of the methods used for solid separation include screens, presses, sedimentation, centrifuges, dissolved air floatation and tangential flow separators.

Waste water treatment using ponds: The most common ponds used for this purpose are aerobic and anaerobic ponds. Farmers prefer anaerobic pond over aerobic because of its ability to convert the effluent as a valuable raw material for biogas plant. The biogas in turn serves as the most eco-friendly source of energy and is also cost effective. Yet, ponds are more effective controller of GHGs emission when they are covered. The most common covering material includes straw or synthetic material like geofabric. Covering ponds allows minimal escape of

GHGs and also reduces odour. Facultative ponds are also being developed which are a combination of aerobic and anaerobic system.

Other Means of Managing Manure

a. Stockpiling or Composting of Manure

Though stockpiling demands minimal input, the degree of odour and emission is higher in comparison to composting. Composting has its own advantages as it reduces moisture content of effluent, is fairly odourless, may be used as an additive on farms, releases more carbon dioxide than methane and reduces nitrogen losses on spreading. Two critical components of composting are watering, needed for the active stage and curing, to optimise the carbon dioxide and nitrogen ratio in immature compost.

b. Manure as Soil Fertilizer

The spreading of effluent onto soil is a very convenient and eco-friendly method, whereby the use of commercial fertilizers can be minimised. But, factors that are to be dealt with include overloading of soil with effluent as this may cause salinization, soil structure decline, acidification, water logging or crop damage.

c. Alternate Manure Treatments

Taking the example of human waste treatment, a few methods have been tried in treating animal waste also. In a laboratory study which included earthworm in a vermifilter fed with swine manure, provided a methane sink and decreased emissions of NH_3 and N_2O (Luth *et al*., 2011). Another study suggested that, addition of nitrite-oxidizing bacteria to swine manure reduced N_2O emissions up to 80.00 per cent (Fukumoto, 2010).

2. Feed Production and Nutrition of Pigs

The primary cause of major GHGs emission during production of feed is deforestation to grow feed crops and use of synthetic fertilizers. The diet of swine and feed conversion efficiency has been recognised as a crucial indicator of GHGs emission especially for ammonia. Pigs that are provided diet according to the physiological and physical demand emit less GHGs. A reduction in crude protein content in diet reduces emissions almost 10.00 per cent for every 10 g kg^{-1} reduction in dietary crude protein. Inclusion of dietary fibre also reduces ammonia emission by about 40.00 per cent due to shifting of ammonia from urine to faeces promoting bacterial growth in the large intestine. Lowering the dietary electrolyte balance or supplementation with acidifying salts like benzoic acid or $CaSO_4$ is related to significant reductions of ammonia. Better feed efficiency by genetic selection or modification of the hormonal status of the pigs is also related to reduce emissions (Philippe *et al*., 2011).

3. Housing of Pigs

Pig housing system (Table 1) is responsible not only for small amount of methane emission but also more amount of ammonia emission.

Table 1: Types of housing

Housing system	Materials used	Characteristics	Total manure and feed emissions
Industrial	Slatted concrete floor, steel roof, covered walls made of steel/brick/concrete/wood.	Completely market oriented with highest level of capital input and minimal use of local ingredients as feed. Herd performance is high.	5.2 kg CO_2-eq/kg CW
Intermed iate	Fully concrete floor, solid roof, walls absent or made with locally available materials.	Completely market oriented with medium level of capital input and about 30 to 50% use of local ingredients in feed. Herd performance is medium.	5.8 kg CO_2-eq/kg CW
Backyard	Enclosed partially with roof made of timber/thatch/bricks etc. and usually with no walls.	Mainly for local markets or for subsistence with minimal capital input and high amount of swill, scavenging materials and locally available fed. Herd performance is low.	5.3 kg CO_2-eq/kg CW.

(Source: Gerber et al., 2013)

Currently global trends in pig housing have evolved different concepts such as-

Lower Stocking Density: Stocking density of 1.2m^2 per pig was most beneficial in terms of social behaviour, manure concentration and body temperature (Lingling *et al*., 2016).

Adoption of Outdoor Farming with a Combination of Conventional Farming and Backyard Farming

Recent reports have revealed that pigs housed in intensive housing tend to suffer from Vitamin D deficiency. Apart from this, tail biting is very common probably due to inability to carry out their natural rooting behaviour. Again, backyard farming is suitable only for a limited number of pigs as large areas are required for grazing. Moreover, proper diet and health management is usually lacking in this method. Outdoor farming may be categorised into- Rotational and Feedlot farming. Rotational outdoor piggeries utilise paddocks, with a simple communal shelter for dry sows, kennels for weaners and individual huts for lactating sows. In feedlot outdoor piggeries, pigs are housed in pens, with the same facilities as for rotational system (Tucker *et al*., 2010).

Farrowing Crates

In the recent times, many countries have adopted the practice of keeping sows in loose conditions as opposed to farrowing crates. It has been proved that farrowing crates increase the stress hormones of sows due to their inability to make nest, inability to move around or defecate and urinate at a different spot. This in turn makes the sow aggressive towards her piglets at times. Though the mortality of piglets are less in farrowing crates, the culling rate of weak or dead pigs were less in free farrowing system.

4. Organic Pig Rearing

Recent times have seen a global demand for organic pork. Organic pig rearing is not easy and demands large cultivable lands, regular access to sunlight and fresh air, solid floor with natural bedding material, rooting facility both indoors and outdoors, access to pasture keeping in mind for minimal pasture damage, prevention of water contamination, proper health management, group housing of sows except for last stage of pregnancy or during lactation, maximum restraining period of 5 days for sows, avoidance of use of synthetic antibiotics or medicines and a diet produced organically with no additives. Some of the newer materials on which experiments are being carried out are titanium dioxide (TiO_2), alkali and alkaline earth metaloxides, hydroxide and carbonates/bicarbonates. Research shows that TiO_2 paint on the interior wall of swine houses lead to oxidation of NH_3 and NO_2 due to stimulation of its photocatalytic properties by Ultra Violet (UV) light (Lee *et al*., 2002; Allen *et al*., 2005). Alkali and alkaline earth metaloxides, hydroxide and carbonates/bicarbonates have been shown to have high CO_2 absorption capacity and are being investigated for CO_2 sorbent applications (Duan *et al*., 2012).

5. Enteric Fermentation

Greenhouse gas emission due to enteric fermentation in pig farming occupies only a small spot of the total amount. It is directly related to feed conversion ratio and digestibility of feed taken. Hence, by improving the quality of feed, emission from this factor can be reduced.

6. Supply Chains

This sector also is a very small contributor to global GHGs emission. The mitigation measures are to be adopted in areas of energy efficiency, waste management and recycling.

7. Genetics

Genetic effect of pigs on GHGs emissions were directly related (Tribout *et al*. 2010). Using superior breeds can also help reduce emission as the need for more number of pigs is reduced. In turn feed requirement, quantity of effluent and energy requirement is reduced. At fewer stocking densities, greater production can be achieved with minimal effect on environment. Further study should be carried out to evaluate breed specific feed efficiency and low methane emission. To enhance the genetic value of offspring, artificial insemination, oestrus synchronization, embryo transfer, gender-selected semen can be used (DeVries *et al*., 2008). Crucial steps in regards to policy measures related to the Kyoto Protocol’s “Clean Development Mechanisms” should be undertaken to provide stimulus and support for small farmers willing to raise livestock sustainably.

Conclusion

India, due to greenhouse gas emission level, ranks at 9th position in Climate Change Performance Index, 2020. Among various livestock species swine is responsible for 9 per cent of livestock sector GHGs emission. In swine farming some areas in which measures can be taken to reduce the adverse effect on climate are management of manure, feed production, nutrition, housing and organic pig farming. Furthermore, emphasis on genetic improvement of the breeds to reduce number of animals reared also to be taken care off.

Conflict of Interests

There is no conflict of interest.

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