



World Bank Regional Agricultural Pollution Study

# An Overview of Agricultural Pollution in Vietnam: The Livestock Sector 2017





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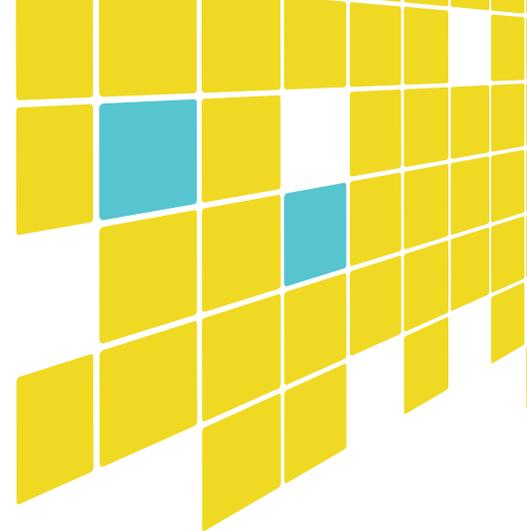
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# CONTENTS



Abbreviations .....	iv
Foreword.....	v
<b>1 Introduction .....</b>	<b>1</b>
<b>2 Analytical framework .....</b>	<b>3</b>
<b>3 Findings and discussions.....</b>	<b>5</b>
3.1 Livestock development and intensification trends.....	5
3.2 MARD’s restructuring of the livestock subsector .....	7
3.3 Livestock production systems and waste management practices.....	7
<b>4 Physical impacts on environment.....</b>	<b>15</b>
4.1 Volume of animal manure generated and discharged to the environment	15
4.2 Types of pollution.....	17
<b>5 Socioeconomic impacts.....</b>	<b>21</b>
5.1 Impacts on human health.....	21
5.2 Impacts on animal health .....	22
5.3 Antimicrobial resistance .....	22
5.4 Economic impacts.....	22
<b>6 Driving factors .....</b>	<b>25</b>
6.1 Trends of production and waste management.....	25
6.2 Constraints in adopting better livestock waste management .....	25
6.3 Lack of incentives for adopting improved livestock waste management ...	26
6.4 Low social pressure .....	26
6.5 Conflicting policies in favor of livestock intensification .....	27
<b>7 Interventions.....</b>	<b>29</b>
7.1 Policies and regulations on livestock waste management.....	29
7.2 Technologies locally available to manage livestock wastes.....	30



<b>8 Knowledge and data gaps.....</b>	<b>33</b>
8.1 Knowledge gaps.....	33
8.2 Data gaps .....	34
8.3 Hot spots deserving in-depth case studies .....	34
<b>9 Conclusions and recommendations.....</b>	<b>35</b>
9.1 Key takeaways .....	35
9.2 Recommendations.....	37
References .....	39
Annex.....	42



## Figures

Figure 1. Analytical framework.....	3
Figure 2. Share of meat by species, 2014.....	5
Figure 3. Share of manure by species, 2014 .....	5
Figure 4. Livestock population trends, 2005–2014.....	6
Figure 5. Production of meat and eggs, 2005–2014.....	6
Figure 6. Gross domestic product, meat production, and meat consumption, 2005–2014 .....	6
Figure 7. Pig manure management practices in Vietnam .....	10
Figure 8. Diagram on wastewater by secondary EM .....	11
Figure 9. Association among housing types, waste management practices, and sanitation.....	13
Figure 10. Volume of animal manure by species, 2010–2014 .....	16
Figure 11. Volume of manure by species and region, 2014 .....	16

## Tables

Table 1. Characteristics of livestock farming systems in Vietnam.....	8
Table 2. Volume of animal waste discharged to the environment by the regions in Vietnam .....	16
Table 3. Total emissions of CO <sub>2</sub> equivalent, 2012.....	18
Table 4. Main legal documents related to livestock pollution.....	42
Waste management practices .....	44

# ABBREVIATIONS

BOD5	Five-day Biochemical Oxygen Demand
CH	Central Highland
CH <sub>4</sub>	Methane
CO <sub>2</sub>	Carbon Dioxide
COD	Chemical Oxygen Demand
DARD	Department of Agriculture and Rural Development
DLP	Department of Livestock Production
EIA	Environmental Impact Assessment
EM	Effective Microorganisms
FO	Farmer Organization
GSO	General Statistics Office
H <sub>2</sub> S	Hydrogen Sulfide
HCMC	Ho Chi Minh City
LCASP	Low Carbon Agricultural Support Project
LIFSAP	Livestock Competitiveness and Food Safety Project
LPC	Livestock Production Cluster
MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
MRD	Mekong River Delta
NGO	Nongovernmental Organization
NH <sub>3</sub>	Ammonia
NMM	North Mountainous and Midland
NO <sub>2</sub> <sup>-</sup>	Nitrite
NO <sub>3</sub> <sup>-</sup>	Nitrate
NSCC	North and South Central Coast
P	Phosphorus
PRRS	Pig Reproductive and Respiratory Syndrome
QSEAP	Quality and Safety Enhancement of Agricultural Products and Biogas Development Project
RRD	Red River Delta
SE	South East
VAC	<i>Vuon-Ao-Chuong</i>
VAHIP	Vietnam Avian and Human Influenza Control and Preparedness Project



# FOREWORD

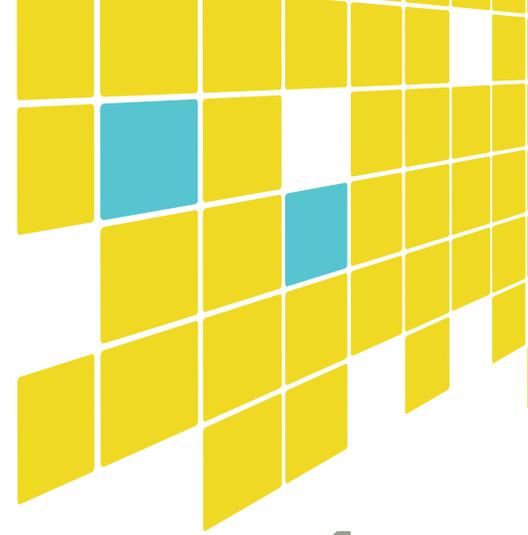
Between July 2015 and December 2016, the World Bank carried out a regional study of agricultural pollution in East Asia with a focus on China, Vietnam, and the Philippines, in cooperation with each country's ministry of agriculture. This effort aimed to provide a broad overview of agricultural pollution issues associated with farming in these countries and the region: their magnitude, impacts, and drivers and what is currently being done about these. It also sought to outline potential approaches to addressing these issues going forward. The study aimed to examine how the structural transformation of the agricultural sector and the evolving nature of agricultural production are shaping agricultural pollution issues and mitigation opportunities. It also set out to identify knowledge gaps, pointing to directions for future investment and research. Ministries of agriculture and environment are the study's primary audience. Its secondary audience consists of development organizations, industry associations, and other actors with an interest in sustainable agriculture and environmental health and protection.

The 'study' constitutes the totality of the work and includes multiple components, including national overviews of agricultural pollution for the three focus countries, thematic working papers, and an overall synthesis report. The present report corresponds to the national overview of agricultural pollution in Vietnam and, specifically, to the background paper on livestock pollution. It provides a broad national overview of (a) the magnitude, impacts, and drivers of pollution related to the livestock sector's development; (b) measures that have been taken by the public sector to manage or mitigate this pollution; and (c) existing knowledge gaps and directions for future research.

The report was prepared on the basis of a desk review of existing literature, recent analyses, and national and international statistics. It did not involve new primary research and did not attempt to cover pollution issues that arise in the broader livestock value chain, outside the farm gate—for instance from slaughterhouses, feed processing plants, or veterinary drug factories. An earlier version of the report was circulated to stakeholders representing national government agencies, nongovernmental organizations (NGOs), and research institutions and discussed at a stakeholder consultation workshop in December 2016. It was finalized by consolidating and addressing comments from various stakeholders and the World Bank task team.

This report was written by Tung Xuan Dinh with inputs from Emilie Cassou and Binh Thang Cao.

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# INTRODUCTION

**In the past 10 years, Vietnam’s population has grown by around 1.03 percent per year, increasing from 83.1 million in 2005 to 93.4 million in 2015.** In 2014, the proportion of urban population reached 31 percent, which increased from 27.1 percent in 2005 (TCTK 2012). Also in this period, the gross national income per capita increased from US\$699 to US\$2,111, changing Vietnam from a low-income country to a lower-middle-income country (World Bank 2016).

**Food demand has also increased rapidly as population and incomes have increased, and food consumption patterns have shifted.** The past decade has seen very high levels of growth in the consumption of meat (especially pork), milk, and eggs—growth rates higher than those experienced by any country in the region (Jaffee et al. 2016).

**Intensification has been the sector’s response to this surge in demand, especially in pig and poultry production, and this pattern has given rise to environmental problems.** Livestock is one of the fastest growing sub-sectors of agricultural production in Vietnam. Over the last 10 years, the livestock production in Vietnam has undergone major changes. The livestock population has been growing while the number of households raising animals has declined. Intensification of livestock farming from big farms often produce wastes much more than their capacity to recycle them for use as fertilizers and biogas. As a result, inappropriate dumping of wastes and lack of waste treatments before discharging into surrounding environment have caused varying degrees of localized water, soil, and air pollution and have had a negative impact on public health, especially in or near densely populated areas.

**The objective of the review was to provide a broad national overview** on (a) pollution related to livestock development—its magnitude, impacts, and drivers; (b) measures that are currently in place to manage or mitigate waste pollution in different farming systems and the potential for addressing the problems when moving forward; and (c) existing knowledge gaps and directions for future research and interventions.

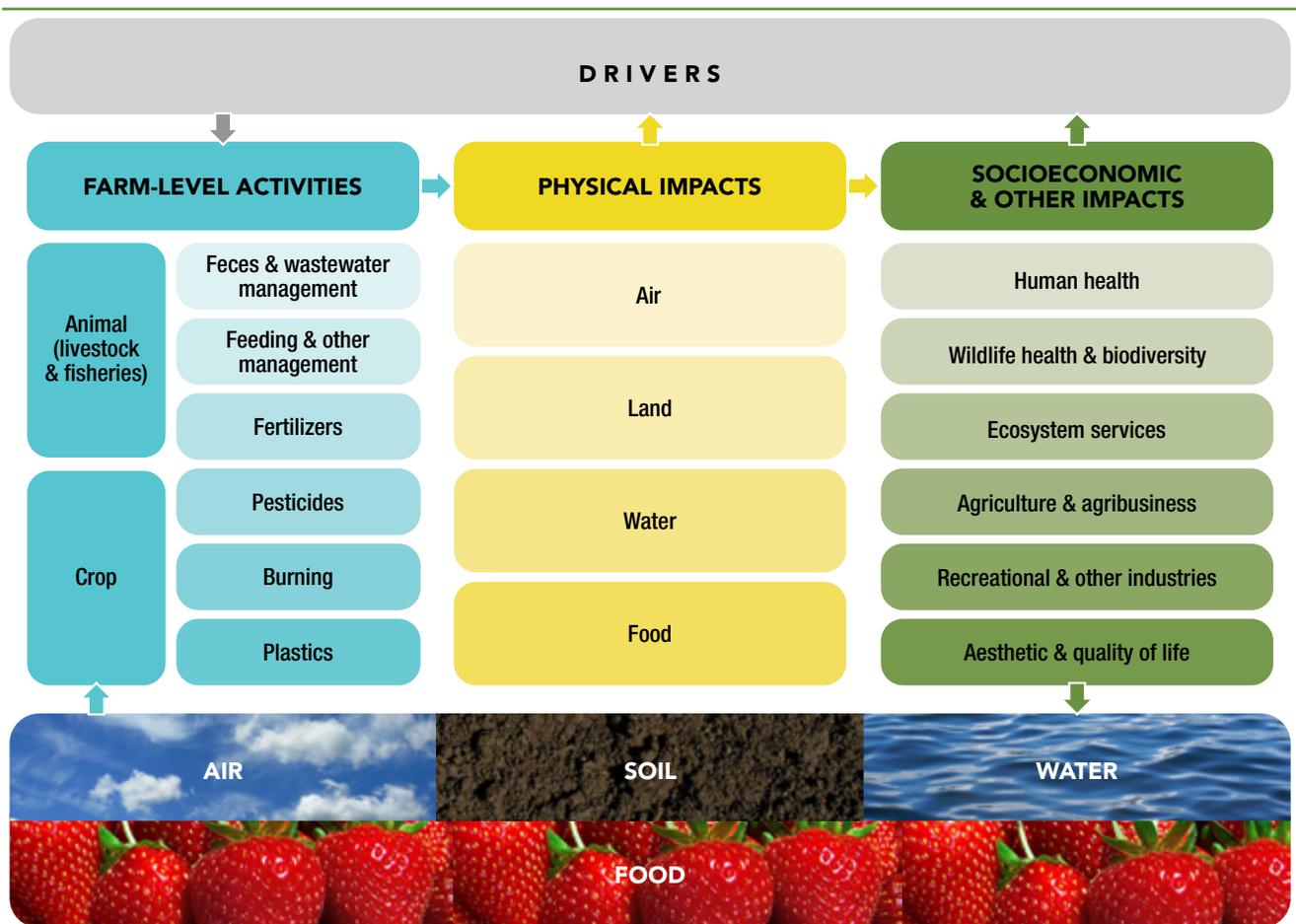
**The paper is organized into nine sections.** Section 1 provides the introduction; section 2 provides an analytical framework; section 3 presents the findings and discussions, which includes livestock development and intensification of trends and production systems, and waste management practices; section 4 presents the physical impacts on environment; section 5 presents the socioeconomic impacts; section 6 presents the driving factors; section 7 discusses interventions; section 8 talks about the current knowledge and data gaps; and section 9 includes conclusions and recommendations.

# ANALYTICAL FRAMEWORK

# 2

Figure 1 presents the analytical framework that guided this study.

Figure 1. Analytical framework



Note: Under socioeconomic and other impacts, wildlife health & biodiversity includes flora and fauna; ecosystem services include climate stability / climate change.



# FINDINGS AND DISCUSSIONS

## 3

### 3.1 Livestock development and intensification trends

**The livestock sector in Vietnam plays an important role in agriculture.** It accounts for 28 percent of agricultural gross value added (FBLI-Booklet 2015) and is one of the fastest growing agricultural subsectors. In 2014, 4.58 million tons of pork, beef, and poultry were slaughtered in Vietnam. Pork dominates Vietnamese meat production (72.6 percent) and is followed by poultry (18.0 percent), beef (6.3 percent), and buffalo (1.8 percent) (TCTK<sup>1</sup> 2012).

**In the past 10 years, the poultry population has increased faster than average.** While the populations of pig, cattle, and buffalo slightly decreased by 0.27 percent, 0.40 percent, and 1.64 percent per year, respectively, the poultry population in contrast increased significantly at a rate of 4.56 percent per year in the same period (Figure 4). More specifically, the number of pigs fluctuated from 27.4 million in 2005 to 26.5 million in 2007, increased again in 2009 and then leveled off in recent years. Similarly, the number of cattle increased from 5.5 million in 2005 to 6.7 million

Figure 2. Share of meat by species, 2014

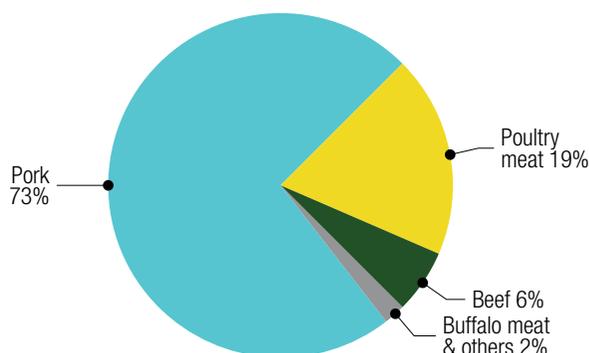
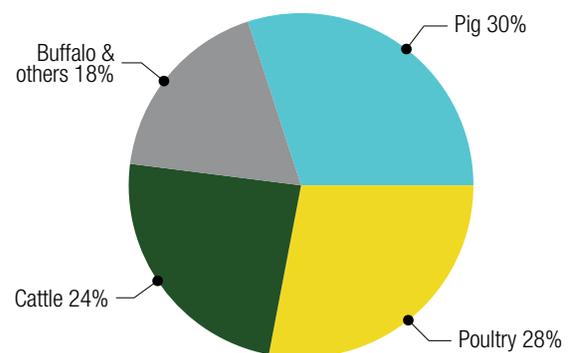


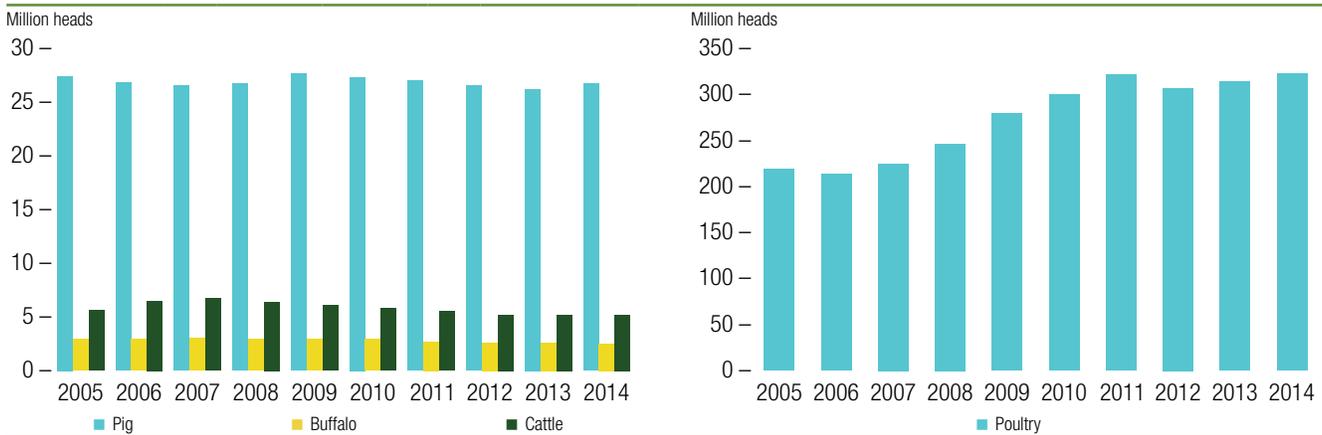
Figure 3. Share of manure by species, 2014



Source: GSO.

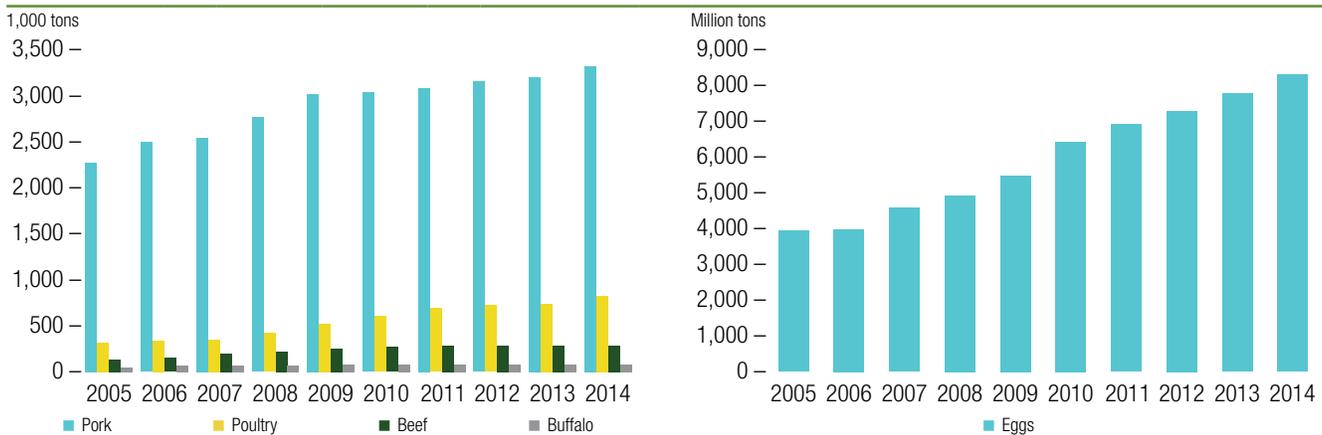
1 Government Statistics Office (GSO).

Figure 4. Livestock population trends, 2005–2014



Source: GSO 2004–2015.

Figure 5. Production of meat and eggs, 2005–2014

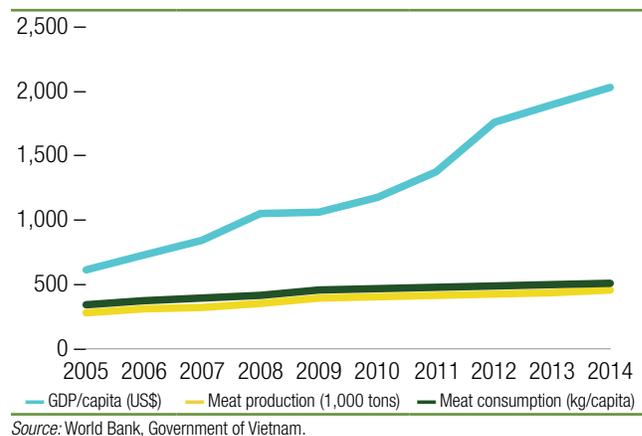


Source: GSO 2004–2015.

in 2007 and then started decreasing. The buffalo population also decreased slowly from 2.9 million in 2005 to 2.5 million in 2014. Only poultry showed a steady increase from 2006 to 2011 and stayed high in recent years. In terms of livestock products, all types of meat and egg products increased significantly with the highest increase found in poultry meat, followed by beef, pork, and buffalo meat (Figure 5).

**Rising demand for livestock products has led to the intensification of livestock systems.** Meat production in the past decade has grown rapidly in response to the growing demand for meat, milk, and eggs. In the past decade, gross domestic product per capita has increased more than three times while meat production only doubled; the country had to import more meat to meet the domestic demand. In 2014, Vietnam spent US\$486 million for importing poultry

Figure 6. Gross domestic product, meat production, and meat consumption, 2005–2014



Source: World Bank, Government of Vietnam.

meat and beef from the United States, Brazil, the Republic of Korea, Australia, and so on. In 2014, the total gross value of Vietnam’s livestock production was

around VND 353,876 billion, of which semi-intensive and intensive production accounted for 64.2 percent (around VND 227,260 billion); the remaining was from extensive and subsistence production (Nguyen 2015).

## 3.2 MARD's restructuring of the livestock subsector

**In 2014, the government promulgated the agricultural restructuring plan, which includes the livestock restructuring plan.** The plan to restructure livestock production envisages changes in the livestock population's spatial distribution, in farming systems, and in value chains, along with institutional strengthening. In the same year, the Ministry of Agriculture and Rural Development (MARD) approved the livestock sector restructuring scheme, working toward greater value added and sustainable development, and an Action Plan for implementation of the sector restructuring scheme. A key aim of these is to increase livestock production efficiency and competitiveness by focusing on five priority areas. These are (a) redistributing livestock population in eight agroecological regions, including gradually moving livestock from densely to sparsely populated areas such as highlands and mountains regions, and relocating livestock zones away from cities and residential areas; (b) changing livestock product composition toward greater proportion of poultry while maintaining swine and cattle; (c) transforming farming systems from small-scale to large-scale farming; (d) enhancing livestock value chains; and (e) strengthening institutions. In line with these, one of the strategies is to promote a change from small-scale and subsistence farming to higher intensification and industrialization through the development of large farms.

The given rationale behind the livestock sector restructuring is the foreseen potential for the livestock subsector to increase its production and quality to meet domestic market demand, contribute to national nutrition security, and reduce reliance on imported sources. 'Sustainable livestock development' is thought

to be achievable through improved feed use efficiency, better management of animal wastes, and improved biosecurity and food safety standards.

## 3.3 Livestock production systems and waste management practices

### 3.3.1 Key characteristics of livestock production systems

**The livestock sector in Vietnam is undergoing a structural change involving a move toward intensive systems and larger production scales.** In the past decade, the number of livestock producers has declined over the years and, at the same time, production has gradually shifted from small-scale to larger-scale and industrial farming (Table 1). For instance, in Dong Nai—the biggest livestock producing province in the country—the number of pigs increased from 1.12 million in 2010 to 1.5 million in 2015, of which, intensive pig farms accounted for approximately 70 percent (that is 2,200 large intensive farms). The remaining were mainly small-scale commercial farms.

**With regard to production volume and economic value, pig raising is the largest sub-sector, followed by poultry.** These two sub-sectors constitute the most important part of livestock production. Pig and poultry farming is practiced widely in all six agroecological regions of the country but is most concentrated in the lowland areas, such as the Red River Delta (RRD), South East (SE), and Mekong River Delta (MRD), whereas ruminants are raised more in mountainous regions, where mixed crop-livestock systems are prevailing. Over 40 percent of the cattle population is concentrated in the North and South Central Coast (NSCC) region; the next largest population is in the North Mountainous and Midland (NMM) region (17.7 percent)

**In the past years, livestock production has also gradually moved from densely to less populated areas, and in this process, new livestock production**

**Table 1. Characteristics of livestock farming systems in Vietnam**

	Pig	Poultry	Beef/buffalo	Dairy
Population and production	<ul style="list-style-type: none"> <li>Number of pigs decreased slowly from 27.4 million in 2005 to 26.7 million in 2014.</li> <li>3.33 million tons of live weight was recorded in 2014.</li> <li>Pork accounted for about 74 percent of total meat in Vietnam (TCTK 2012).</li> </ul>	<ul style="list-style-type: none"> <li>There were 324.6 million birds in 2014, which increased 1.47 times during 2005–2014.</li> <li>873,200 tons of meat was recorded in 2014.</li> <li>Poultry was the second largest, accounting for 19 percent of total meat produced in Vietnam (TCTK 2012).</li> </ul>	<ul style="list-style-type: none"> <li>Cattle increased steadily from 5.5 million in 2005 to 6.7 million in 2007 and then started decreasing.</li> </ul>	<ul style="list-style-type: none"> <li>227,600 tons of dairy products were produced in 2014, which increased at 2.1 times during 2005–2014.</li> <li>549,533 tons of milk was produced in 2014 (TCTK 2012).</li> </ul>
Production scales	<ul style="list-style-type: none"> <li>In 2014, 70 percent of pig heads and 60 percent of pork products were produced by the householder farms and the rest are from large-scale commercial pig producers (DLP-MARD 2015a; Dzung 2013).<sup>a</sup></li> <li>Number of pig-raising farms fell by more than 65 percent between 2005 and 2014. In 2014, farms with 10 pigs or more accounted for supply of 65.8 percent of pork to markets (Đinh 2009a; TCTK 2012).</li> <li>In 2008, smallholder farms accounted for 85 percent of total pig population, and 15 percent were from commercial pig farms (Hoàng 2012a).</li> </ul>	<ul style="list-style-type: none"> <li>In 2013, smallholders (1–50 birds) accounted for 89.6%; semi-industrial (50–99 birds) 7.2%; and industrial farms (&gt;100 birds) only 3.25% (TCTK 2012).</li> <li>In 2008, chicken commercial farms (200 to 500 heads) ranged from 10% to 15%. 0.1% is integrated industrial farms (&gt;2,000 chicken heads) (Desvaux 2008).</li> </ul>	<ul style="list-style-type: none"> <li>Average herd size per cattle farm was 6.2 heads.</li> <li>Households having more than 10 cattle accounted for 10%.</li> <li>The figures for buffalo were 1.9 heads per farm and 1.5%, respectively (Đinh 2009a).</li> </ul>	<ul style="list-style-type: none"> <li>In the RRD, 90% of cows were owned by individual farmers with an average of 3.91 dairy cows per farm (Đinh 2009b).</li> <li>In HCMC, farms of less than 20 dairy cattle accounted for 98.9% of the dairy cattle population (Thi Dan et al. 2003).</li> </ul>
Main regions	<ul style="list-style-type: none"> <li>The RRD has the largest pig population (324 heads per km<sup>2</sup>), followed by the SE and MRD regions.</li> <li>Large-scale pig farms tend to be around major cities, such as Hanoi and HCMC.</li> </ul>	<ul style="list-style-type: none"> <li>Average density was 648 heads per km<sup>2</sup>. The RRD, MRD, and SE have the highest density of poultry farming.</li> </ul>	<ul style="list-style-type: none"> <li>NSCC region had nearly half of the cattle population.</li> <li>NMM region accounted for 56.7 percent of total buffalo population.</li> </ul>	<ul style="list-style-type: none"> <li>In 2014, around 83.8% of cows were located in only six provinces / central cities (Hanoi, Son La, Nghe An, Lam Dong, HCMC, and Long An).</li> </ul>

**clusters (LPCs) have formed.** These dynamics are taking place more clearly in areas around big cities (that is, Hanoi and Ho Chi Minh City [HCMC]). For example, Thai Binh Province is located about 100 km from Hanoi. This province ranks fourth in terms of the number of pigs. It has 285 communes; however, pig farming tends to be concentrated only in one-third of the communes (99 communes), specifically in 137 LPCs spanning 1,087 ha. Although relocation of livestock production from one commune to other communes has been observed, movement has not been observed between provinces. This is because each province is trying to keep its own livestock production plan through rearrangement of the present livestock production distributions. For example, Hanoi has

developed 15 LPCs; Hai Duong and Thai Binh also each have 7 LPCs.

**Together with the trends of larger scales and intensification, environmental pollution is getting more severe due to improper handling of animal wastes and inappropriate use of commercial feeds.** A majority of pig and poultry farms now use commercial feeds, though some smallholder farms still use traditional feeds (that is, rice and rice bran). Besides high nutrient contents (that is, nitrogen and phosphorus), commercial feeds also contain antibiotics and some heavy metals (since 2014, growth hormones have been banned from feed by Vietnam's veterinary authority). Sixty percent of pig feed samples reportedly showed at least one type of the antibiotics

**Table 1. Characteristics of livestock farming systems in Vietnam**

	Pig	Poultry	Beef/buffalo	Dairy
Feeding systems	<ul style="list-style-type: none"> <li>• Pig raising consumed around 70% of the total of 14.4 million tons of industrial feeds per year (DLP-MARD 2015b; Nguyen 2015).</li> <li>• Over two-thirds of pig farms used commercial feed. The number of commercial pig farms using industrial feeds accounted for 86.3%, while small-scale commercial pig farms accounted for only 42%, and smallholder farms accounted for 25.7% (Hoàng 2012b).</li> <li>• Around 60 percent of pig feed samples showed at least one type of the antibiotics of tetracycline and tylosin groups, of which one sample had tylosin exceeding permissible limits (ACE Europe 2013).</li> </ul>	<ul style="list-style-type: none"> <li>• Poultry used about 30% of the total of 14.4 million tons of industrial feeds per year (DLP-MARD 2015b; Nguyen 2015).</li> <li>• Most poultry farmers used commercial feed for feeding.</li> <li>• Around 70% of broiler feed samples showed at least one type of the antibiotics of tetracycline and tylosin groups (ACE Europe 2013).</li> </ul>	<ul style="list-style-type: none"> <li>• The pen systems accounted for a small proportion (Đinh 2009a).</li> </ul>	<ul style="list-style-type: none"> <li>• Cows were fed between 20 kg and 40 kg of roughage and fresh matter.</li> </ul>
Housing systems	<ul style="list-style-type: none"> <li>• The most common housing types were permanent stalls.</li> <li>• 71.8% of commercial farms had concrete floor, followed by small-scale commercial farms (68.7%), and smallholder poultry farms (48.2%)<sup>b</sup></li> <li>• In industrial pig production, windowless houses accounted for only 3%, semi-windowless houses accounted for 21%, and open style swine house accounted for 76.0% (Trình 2010).</li> </ul>	<ul style="list-style-type: none"> <li>• In smallholder poultry farms, semi-permanent stalls and simple pens account for an estimated 42% and 11%, respectively (2010 assessment)</li> </ul>	<ul style="list-style-type: none"> <li>• Number of cattle farms with permanent pens accounted for 34.7%. The highest ratio was found in the North Central Coast region (97.1%) and the lowest in Central Highland (CH) region (Đinh 2009a).</li> </ul>	<ul style="list-style-type: none"> <li>• Majority of smallholder farms had permanent pens.</li> </ul>

Note: a. MARD's definition of smallholder varies by animal species:

- Breeding pig: >20 sows is commercial farms, <20 sows is smallholder farms.
- Fattening pig: >100 pig per batch is commercial, and <100 is smallholder farms.
- Poultry: >2,000 birds per batch is commercial, <2,000 is smallholder farms.
- Cattle/buffalo: for breeding, >10 cows is commercial and for fattening, >50 heads is commercial.

Not all publications, however, adhere to this classification. Some authors simply refer to small, medium, and large farms.

b. Đánh giá thực trạng ô nhiễm môi trường trong chăn nuôi. <http://www.vusta.vn/vi/news/Thong-tin-Su-kien-Thanh-tuu-KH-CN/Danh-gia-thuc-trang-o-nhiem-moi-truong-trong-chan-nuoi-32705.html>.

of tetracycline and tylosin groups. Nutrients and antibiotics and other residues in untreated animal manures, when released to surrounding land and water, are the main causes of localized pollutions. According to the Hanoi Department of Agriculture and Rural Development (DARD), Hanoi had 1,223 commercial farms as of 2010.<sup>2</sup> Most of them were small-scale, and 80 percent of these were located in residential areas. Environmental pollution caused

by livestock production is the biggest risk for both livestock and public health.

**Realizing the constraints, the government is promoting zoning and the establishment of LPCs to engage livestock producers in high-value supply chains and to control environmental pollution and diseases.** Although these zoning processes have started in some provinces, to date, they are still at a

2 Xử lý ô nhiễm môi trường trong chăn nuôi: Còn nhiều gian nan. <http://pda.vietbao.vn/Kinh-te/Xu-ly-o-nhiem-moi-truong-trong-chan-nuoi-Con-nhieu-gian-nan/410312880/87/>.

pilot scale. The main constraints to this policy are the high investment costs and land availability to develop public infrastructure for new LPC zones. In addition, it also requires high capital investment from producers to move their production from existing places to the new ones. To date, at the time of writing, only a few large-scale farmers have been willing to move, while a majority of small farmers have been reluctant to buy into this policy.

**Given the above trends and constraints, small farmers are expected to exit livestock production in the near future and they will be replaced by commercial producers who have adequate resources to compete and comply with environmental standards.** For instance, there were around 4 million smallholder farms in 2014. It is predicted that this number will be further reduced to 1.5–2 million by 2025. This process, however, would depend on many factors, especially institutional and economic ones.

### 3.3.2 Animal wastes management practices

**Animal wastes are currently being managed in a variety of ways that include composting, the use of biogas digesters, and the direct use of raw manure as fertilizer.** In composting, solid wastes are collected and composted to produce organic fertilizers whereas the liquid fraction is washed off the floor and discharged to the surrounding environment or fishponds. In biogas, wastes are collected and treated in biogas tanks; gasses produced are used for cooking and biogas effluents are used as fertilizers or discharged into fishponds for farming fish. In some places, raw manure (that is, chicken manure) is sold and applied directly to crops as organic fertilizers. Waste management practices are diverse, depending on specific farm conditions, such as types of animals, housing systems, locations, and farm sizes.

Figure 7. Pig manure management practices in Vietnam



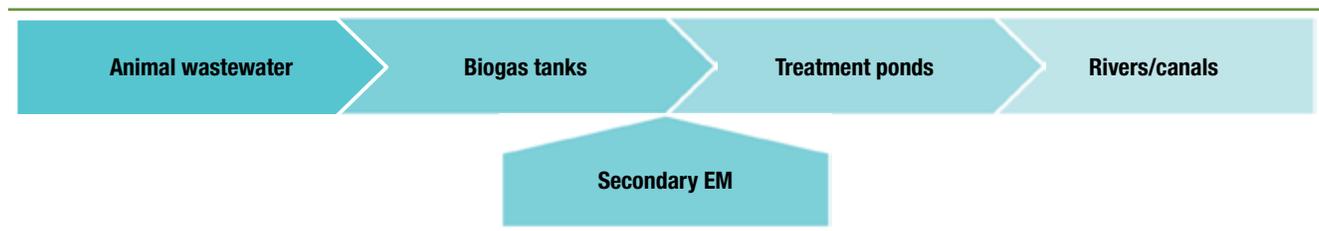
### Waste management practices in pig farming

**In Vietnam, the area of land for waste disposal in pig farms is often very small, especially in the northern commercial pig farms** (34 m<sup>2</sup>). About 30 percent of pig farms are reported to practice separate collection of solid and liquid waste, and 60 percent of farms treat wastes in the form of a mixture.

**In pig farming, the use of biogas digesters to treat waste is fairly widespread.** About 53 percent of pig farms in the south, 60 percent in the north, and 42 percent in the central regions were reported to use biogas digesters for waste treatment (Vũ 2014). The majority of commercial farms (81 percent) had biogas digesters for waste treatment, while only around 12.7 percent of smallholder farms used these (Đinh

the treatment of wastewater from biogas digesters in Vietnam has reportedly brought the concentration of chemical oxygen demand (COD), five-day biochemical oxygen demand (BOD<sub>5</sub>), nitrite (NO<sub>2</sub><sup>-</sup>), nitrate (NO<sub>3</sub><sup>-</sup>), phosphorus (P) total, and coliforms (after 15 days of treatment) to acceptable levels, with reference to MARD's 2016 wastewater standards. Experiments using water hyacinth to treat wastewater after biogas (that is, hyacinth per water surface area of 75 percent) showed similar results that after 30 days of treatment, the concentrations of COD, BOD<sub>5</sub>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, total P, and coliform were within the acceptable limits of the wastewater standards (Trịnh 2010). Despite the promising results, these practices still are not widely adopted by farmers because they require a relatively large treatment area and most small farmers in Vietnam do not have adequate space.

Figure 8. Diagram on wastewater by secondary EM



2009a). In many smallholder farms, solid wastes are collected and composted with rice straw and used as fertilizer for crops. There is a relationship between the use of biogas digesters and the availability of land to house these on (Thi Thien Thu et al. 2012). Where biogas digesters are used, it is quite common that liquids and solids are mixed and put into digesters. About 35.5 percent of pig farms reported storing their pig wastes without treatment and about 40 percent of pig wastes were discharged directly into the environment without treatment (DLP-MARD 2015a).

**A few experiments involving the treatment of biogas digester wastewater with secondary effective microorganisms (EM) have yielded good results in experimental conditions.** Secondary EM are beneficial microorganisms that promote the decomposition of organic matter in anaerobic conditions and can be helpful in suppressing certain odors and pathogens. The use of secondary EM in

### Waste management practices in poultry farming

**Poultry manure tends to be farmers' preferred type of organic fertilizer because it contains high protein content and other essential nutrients for plants.** In addition, it has a high content of dried matter and it is more easily collected and handled and less costly to transport compared to other animal wastes. It is quite common for farmers to apply litter directly to crops (or to temporarily store it for this purpose) after removing it from poultry houses.

**In commercial farms, chicken manure is mostly sold to collectors directly without treatment.** Farmers and fertilizer producers may come and buy solid manure directly at chicken farms or through middlemen. Chicken manure is a preferred source of organic fertilizer for coffee, pepper, and fruit trees (Thi Dan et al. 2003). In 2014, approximately 23.4 million tons of poultry manure was reportedly generated from

poultry farms, of which about 75 percent was directly used as fertilizer.

### Waste management practices in dairy cattle

**In dairy farming, approaches to waste treatment vary greatly among locations.** These include traditional approaches that involve digging a hole underground to store manure and using biogas digesters to treat wastes and produce gas for household uses. Some farms sell wastes to local collectors for composting. An environmental study on dairy farms in Ba Vi showed that about 72.2 percent of dairy-raising households used biogas digesters for waste treatment and the remaining households (27.8 percent) used composting (Lê 2012). However, in dairy farms near big and mid-sized cities like Hanoi, HCMC, and Vinh City in Nghe An province, the amount of manure exceeded the land's nutrient load capacity (Lê 2012, Duteurtre et al. 2015). Enforcement of environmental regulations was weak to protect surface and groundwater from contamination by dairy cow manure. In Vietnam's biggest and most modern commercial dairy company, TH True Milk Company, located in Nghe An, bio-mat bedding is used to collect the solid part of manure in the barn. Because collected litter is a good source of organic fertilizer, the farm sells it to rubber and coffee plantations. The liquid wastes are treated in an industrial station (treatment capacity is 60 m<sup>3</sup> per hour, which is equal to 1,500 m<sup>3</sup> per day), in which it will undergo three stages of treatment—sedimentation, strainer (at this stage, the water is still yellow), and treatment with chlorine (bleach water). After treatment, the wastewater is discharged into a nearby lake (Duteurtre et al. 2015).

### Beef cattle and buffalo waste management

**Most cattle and buffalo continue to be raised in extensive, low-intensity systems, and the wastes these generate have yet to cause major environment problems at this stage; however, this situation is changing.** Most manure is collected or recycled back to grazing lands. However, with the emerging of some large-scale commercial farms, such as Hoang Anh-Gia

Lai Corporate and other companies, there could be environmental pollution in the future. Smallholder, small-scale, and large-scale commercial cattle farms with separate manure treatment areas were reported to be around 48.3 percent, 55.1 percent, and 51.7 percent, respectively. Those using composting method for manure treatment were reported to be around 38.7 percent, 34.4 percent, and 24.1 percent, respectively. A large proportion of liquid waste (76.5 percent of smallholder, 65.5 percent of small-scale, and 75.8 percent of large-scale cattle farms) was discharged directly to the environment. The percentage of buffalo-raising households in the NMM, North Central Coast, and South Central Coast regions having compost piles were reported to be around 31.1 percent. Only 0.5 percent of surveyed households used biogas digesters, and they were mostly located in the NMM region (Đinh 2009a).

**Cattle manure is characterized by high fiber content, a lower concentration of protein, and a less offensive odor.** Cattle manure is widely used as a source of organic fertilizer for various crops such as elephant grass, bonsai, coffee, pepper, and fruit trees. It is common for the manure to be dried under the sun for about three to four days and then mixed with lime, rice straw, rice husk ash, or coconut fiber. Liquid cattle manure can be used to make biogas as well as fertilizer for elephant grass and gardens (Thi Dan et al. 2003).

### Animal housing types in relation to waste management practices and farm sanitation

**There is a relationship between animal housing on the one hand, and farms' waste management and sanitation practices on the other.** Certain types of animal housing make manure collection and handling easier, reducing odor and air pollution. If the floor of the structure is constructed with a gentle slope, for example, this facilitates cleaning and waste collection (the slope eases its flow toward biogas digesters, ponds, tanks, and so on). Pollution levels tend to increase with production scale. Among the three main animal species (that is, pigs, cattle, and poultry), pig production results in the highest levels of pollution in both absolute and relative terms (Phùng et al. 2009).

Proper animal housing is not only essential to animal health but would also help ensure good farm sanitation conditions.

**Figure 9.** Association among housing types, waste management practices, and sanitation



### 3.3.3 Development trend of livestock subsector in relation to environmental pollution

**In recent years, many small producers exited livestock production while larger producers entered.** This trend may accelerate in the coming years due to limited land availability and more enforcement of environmental standards. In large-scale production systems, animal waste management is generally more effective. However, the shift to larger-scale production has not always improved environmental outcomes, despite the higher capacity for pollution management that one might expect from a larger-scale, professional operation. When thousands of pigs are concentrated in a small area, their environmental and health impacts become concentrated too. Large-scale farms generate too much waste for the manure to be applied to surrounding land. In addition, even if they treat a majority of the waste they generate, when a proportion of the waste is discharged into the environment or when liquid manure leaks out, this can create significant problems.

**One typical example is the case of the large-scale pig-breeding farm of Thai Duong Limited Company at Dai Son Commune of Do Luong District in**

**Nghe An Province.** Many local people gathered around their pig farm to protest the severe pollution it was inflicting upon the local environment. In 2011, animal wastes from the farm were reported to have damaged 14.2 ha of rice land and 4.2 ha of fishponds and contaminated drinking water of 16 households in the commune.<sup>3</sup> Air pollution from the farm was also affecting locals' health and day-to-day lives. If there were more commercial farms like this, the impact of livestock production on the local environment and public health would be much more serious than what we are seeing now.

**Managing the environmental risks associated with the intensification of the livestock subsector will require more effective enforcement of policies and legal documents relating to the protection of the rural environment.** A comprehensive, systematic review of environmental regulations, implementation, and enforcement is needed to replace those that are not practical or less effective in reality. The division of responsibilities relating to environmental protection and management currently lacks clarity at the district and commune levels. This needs to change. In addition, capacity building in environmental management at the district and commune levels is badly and urgently needed.

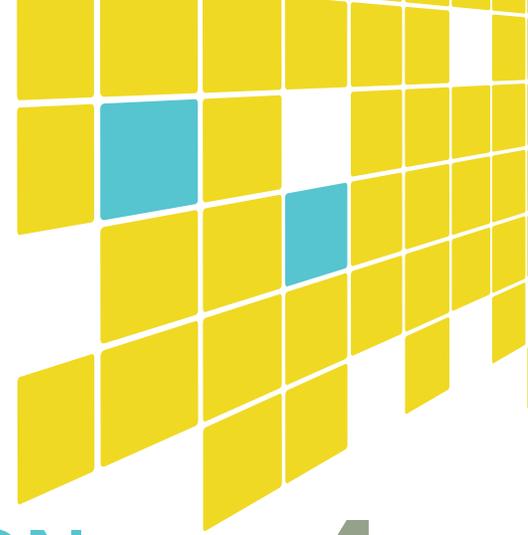
**Policy reforms are needed to better help different types of farms comply with existing environmental standards.** At present, livestock waste management in smallholder farms is neither monitored nor enforced. From the producers' perspective, the treatment of wastes requires onerous investments in infrastructure, which small farmers can hardly afford. A lack of awareness about the importance of waste treatment also factors in to farm-level decisions. Meanwhile, waste management regulations are not uniformly and systematically enforced by the government, especially among smallholder farms. The result is that farmers tend to avoid treating animal wastes when and where possible. In recent years, the government has initiated livestock projects that offer financial support (for example, matching grants) to smallholder farmers to help them handle livestock wastes better, notably

3 Hàng trăm người bao vây trại lợn gây ô nhiễm. <http://www.tinmoi.vn/hang-tram-nguoi-bao-vay-trai-lon-gay-o-nhiem-01636989.html>.

through the construction of biogas digesters and composting facilities.

**While the construction of biogas digesters is viable for some small-scale pig farms, it is not yet an attractive measure for large-scale farms in light of the large volumes of animal wastes they generate—as these lead to excessive volumes of biogas and biogas slurries.** Only a small proportion of gasses produced by medium- and large-scale farms is used for cooking, and most of the remaining excessive gasses are burned or discharged into the environment. Some farms try to install generators operated by gas to produce electricity. However, it is not yet economically viable due to (a) low electricity prices maintained by the state; (b) the technical complexity and expense of constructing medium- and large-scale biogas digesters; (c) limitations of gas purification technology (which is currently not good enough to remove all hydrogen sulfide [H<sub>2</sub>S] and water vapor in the gasses—impurities that can damage generators); and (d) the high cost of high-quality generators. The release of gasses and slurries from biogas digesters remains a big problem in medium- and large-scale pig farms.

**Local governments need to pay greater attention to environmental enforcement for both large-scale and smallholder farms right from the registration stage, strictly monitor waste handling and treatments during operation, and apply appropriate penalties for violators.** Enforcement is frequently a big problem in Vietnam, especially in rural areas, and this needs to change if the government really wants to lessen the impact of the livestock sector. The government needs a clear road map and action plan to implement its existing policy of relocating large-scale farms—many of which are currently located in residential areas—to livestock cluster zones benefitting from province-level support. It also needs to continue providing technical assistance to smallholder farms to help them improve their waste management practices.



# PHYSICAL IMPACTS ON ENVIRONMENT

## 4

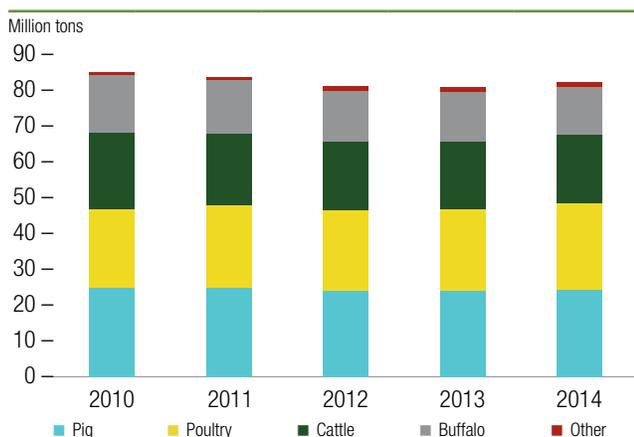
### 4.1 Volume of animal manure generated and discharged to the environment

**The shift from traditional extensive livestock farming to intensive animal production is generating growing volumes of animal wastes.** As of 2015, pig farming generated the highest proportion of manure (30.3 percent), followed by poultry (27.4 percent), cattle (23.7 percent), buffalo (17.1 percent), and others such as goats and horses (1.3 percent). Pig farming was concentrated mainly in lowlands and populated areas. It causes the greatest pollution compared to other animal farming species. Pig manure is also in slurry form and not easily collected.

**Vietnam generates an estimated 80 million tons of animal wastes per year** (DLP-MARD 2015b). About 80 percent of the manure is generated by smallholder farms, and the remainder comes from commercial farms. Smallholder farms account for the largest share of buffalo farms (98.8 percent), but also a high percentage of cattle (89.4 percent), pig (75.0 percent), and poultry farms (71.8 percent).

**The farm animal population is unevenly distributed among Vietnam's regions.** The regions with the largest animal populations include the RRD, MRD, and SE. The volume of animal wastes per km<sup>2</sup> is around 239.8 tons. The RRD generates the largest volumes and is followed by the SE and MRD regions. The three provinces that generate the largest volume of pig manure per km<sup>2</sup> are Thai Binh (598.2 tons per km<sup>2</sup>), Hanoi City (389.9 tons per km<sup>2</sup>), and Dong Nai (219.2 tons per km<sup>2</sup>).

**Around 36 percent of total animal manure is estimated to be discharged directly into the environment, with the rate ranging from 16 percent in intensive farms to 40 percent in smallholder farms.** From a species perspective, pig farms discharge the highest percentage of manure directly into the environment (42.4 percent). The next highest percentages are found in buffalo (41.1 percent), cattle (32.6 percent), and poultry farms (28.8 percent). In every region, smallholder farms discharge a

**Figure 10.** Volume of animal manure by species, 2010–2014

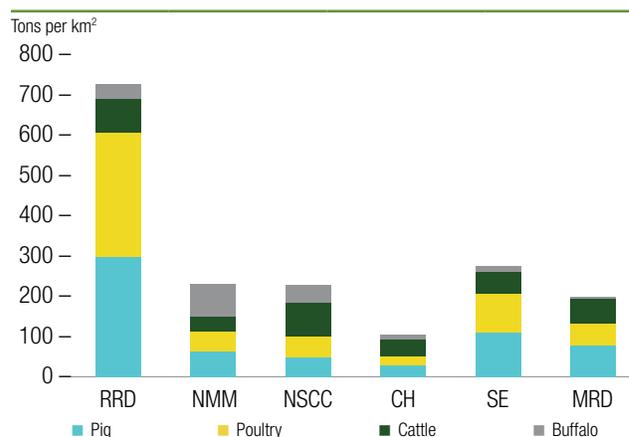
Source: Bàn 2013; Lam 2011; Mosquera, et al. 2012; Vu, Tran, and Dang 2007; DLP-MARD 2015b.

larger volume of manure directly to the environment than intensive farms (Table 2). In the RRD—the region with the largest pig population in Vietnam—it was reported that 82 percent of manure from intensive farming systems was treated while only 39 percent of manure from extensive farming systems was treated (Đinh 2009a; DLP-MARD 2015b). There are large variations in the degree of animal waste pollution among regions and even within provinces, with these partly reflecting the differences in livestock density in different locations (Table 2).

**Table 2.** Volume of animal waste discharged to the environment by the regions in Vietnam

1,000 tons							
Regions/ farm types	RRD	NMM	NSCC	CH	SE	MRD	Country
<b>Pig</b>							
Smallholder	2,469	2,993	1,901	334	554	1,140	8,755
Intensive	392	181	190	48	185	253	1,606
<b>Poultry</b>							
Smallholder	1,835	2,097	1,804	292	221	399	5,668
Intensive	197	74	100	9	111	177	677
<b>Cattle</b>							
Smallholder	360	1,495	4,182	394	337	706	6,025
Intensive	—	66	116	49	20	12	207
<b>Buffalo</b>							
Smallholder	221	4,375	1,761	195	108	96	5,913
Intensive	—	38	—	—	—	—	—
<b>All</b>							
Smallholder	4,885	10,960	9,647	1,214	1,220	2,340	26,361
Intensive	—	360	406	106	315	443	1,630

Note: Author's calculations.

**Figure 11.** Volume of manure by species and region, 2014

Note: Author's calculations.

### Livestock waste pollution hot spots

**Most of the heavily polluted locations so far are the areas having high densities of farm animals.** Some badly polluted livestock communes recently have been mentioned in the public media; Ngoc Luc commune of Binh Luc District in Hanam Province was one of them. This commune is located in the RRD—the region with the highest pig-farming density in Vietnam. On December 23, 2015, the Voice of Vietnam radio broadcast that almost all pig farms in this commune discharged pig manure directly to the commune's small drainage systems. From there, the waste flowed into ponds and fields, making a large part of agricultural land heavily polluted and uncultivable. Although pig production has brought economic benefits to households and the local economy, its economic profits have arguably not compensated for the health costs suffered by thousands of people. Another example is from the Cu Chi District in HCMC, where many small dairy farms were found to be generating larger volumes of manure than they could handle. Dairy cows stayed in barns all day, depositing manure. Manure accumulated over time, causing severe land, water, and air pollution, which in turn badly affected the health of local residents (ACE Europe 2013).

## 4.2 Types of pollution

**Livestock wastes cause different types of pollution, including water, soil, and air pollution.** As previously noted, it is estimated that only around 60 percent of animal wastes are treated; the remainder are discharged directly into the environment (that is, dumping on land, fishponds, canals, rivers, and so on). When accumulated wastes reach beyond the carrying capacity of the local receiving land or water bodies, the untreated wastes would result in severe pollution of soil, surface water and groundwater, and air quality in those receiving areas.

### 4.2.1 Water pollution

**There is evidence that animal wastes and chemicals used in agricultural activities are the main causes of water pollution in rural areas.** Contamination of water bodies normally occurs through various routes, such as direct discharge/dumping of improperly treated solid wastes and wastewater, indirect infiltration of contaminants into groundwater from unlined waste containers/ponds, overflows from locations where solid wastes are stored/disposed, runoff from land application of manure, leaching from manure that has been improperly spread on land, and deposition of airborne contaminants onto surface waters (Burkholder et al. 2007; Hribar et al. 2010).

**A large amount of animal wastes was discharged directly into the environment.** This resulted in water pollution problem. Organic matter, pathogens, and chemical residues from discharged manure follow natural water flows and go into local canals and rivers; some of these penetrate deeply into groundwater. Depending on the concentrations of pollutants, they pollute both surface water and groundwater to varying degrees (Porphyre 2006).

**In pig farming, about 70–90 percent of nitrogen, minerals (P, potassium, magnesium, and others), and heavy metals contained in feed are reportedly**

**excreted to the environment.** These substances concentrate in farm effluents. In terms of bacterial pollution, the level of wastewater contamination (by coliform) caused by smallholder farms was found to be 278 times higher than the permitted level, while that of commercial farms was 630 times higher than the permitted level (Phùng et al. 2009). *Escherichia coli* (*E. coli*) contamination caused by smallholder farms was 8.9 times in excess of the permitted level and 22.1 times by commercial farms. Total coliform concentration in wastewater after biogas and washing water in pit stalls and bathwater for pigs exceeded the permitted threshold 4–2,200 times. BOD5 and COD levels in biogas wastewater from livestock farms in the North region exceeded the permitted limit by 3–5 times (Vũ 2014).

#### Evidence of water contamination

**Research and data on water contamination for specific water bodies so far are limited.** Newspapers and public media have mentioned some cases of water pollution caused by livestock manure. However, most of the reports are of a qualitative nature; there have been few data analyses on the scale and scope of pollution.

**A few cases in HCMC.** In a 2016 newspaper interview with Hai Binh, a staff member of the Natural Resources and Environmental division of HCMC's 12<sup>th</sup> district, confirmed that water pollution in the Tran Quang Co canal is caused by pig farms. In this area, wastes discharged from livestock farms are ruining local canals every day and causing misery among the people living in the surrounding area. According to the statistics, the wards that house many pig farms included Tan Chanh Hiep (92 farms), Hiep Thanh (97 farms), and Thoi An (80 farms). Each farm has from a few dozens to several hundred pigs. According to Hai Binh, many households do not have biogas digesters. In the past, the land was extensive and pig raising was comfortable. However, in recent years, pig farms have caused heavy

odors, and the wastewater they discharge into the environment has caused problems for local residents.<sup>4</sup>

According to the Environmental Protection Department of HCMC, wastewater from livestock farms is among the major causes of drinking water pollution affecting city dwellers. After being discharged into canals, wastewater flows into the Saigon River, which is the main source of water supply for drinking and domestic uses in the city. Livestock waste has now been included in the list of pollution sources that require tight control by the public authority to protect water quality in the Dong Nai-Saigon river system.

#### 4.2.2 Soil pollution

**A few studies in Vietnam show that animal wastes from livestock farms, which are disposed on agricultural land without a suitable nutrient management plan, result in overfertilization of the soil, toxic runoff, and the leaching of contaminants.** This then poses risks to the adjacent water environment and may affect drinking water sources (Burkholder et al. 2007). Causes of pollution linked to intensive pig farming are well known. Pigs excrete about 70–90 percent of the nitrogen, minerals (P, potassium, magnesium, and so on), and heavy metals present in feed. The excreted nutrients and heavy metals concentrate in the manure and effluents from the farms (Porphyre 2006). Direct discharge of animal wastes onto soil without prior treatment pollutes the receiving soils. Observations show that land in and

near densely populated pig farms is contaminated by livestock wastes to various degrees. There have been few studies and data on this phenomenon, however.

#### 4.2.3 Air pollution

**The decomposition of livestock wastes generates carbon dioxide (CO<sub>2</sub>), NH<sub>3</sub>, CH<sub>4</sub>, H<sub>2</sub>S, bacteria, endotoxins, volatile organic compounds, odorous substances, and fine particles** (Bunton et al. 2007). Livestock production was reported to be one of the major contributors to greenhouse gas emissions (Table 3). Livestock manure is also a source of odor pollution, and there is a risk of diseases spreading. Air pollution includes odors emanating from the decomposition and putrefaction processes involving organic matter in manure, animal urine, and uneaten feed. The intensity of bad odor depends on the amount of manure released, ventilation conditions, temperature, and humidity. The proportions of NH<sub>3</sub>, H<sub>2</sub>S, and CH<sub>4</sub> released from animal wastes vary along with the stages of the decomposition process, organic materials, composition, microorganisms, and animal health condition (Huynh et al. 2010).

**NH<sub>3</sub> and H<sub>2</sub>S gas concentrations in air emissions from pig farms in the North region were reported to be 7–18 times and 5–50 times, respectively, higher than the permitted levels** (Vũ 2014). A study on environmental pollution caused by livestock production in 2009 showed that air pollution (NH<sub>3</sub> concentration) was 18 times higher than the permitted

**Table 3.** Total emissions of CO<sub>2</sub> equivalent, 2012

Tons per year					
Animal species	Pig	Poultry	Buffalo	Cattle	Total
Total CO <sub>2</sub> equivalent	4,328,080	535,590	3,749,477	6,344,163	14,960,935
RRD	1,045,673	144,732	215,74	708,294	2,114,968
NMM	905,692	115,801	2,071,907	1,074,209	4,168,113
NSSC	855,113	113,503	1,195,645	2,535,322	4,701,184
CH	280,665	20,557	124,448	797,644	1,223,410
SE	528,351	26,768	82,886	477,021	1,115,500
MRD	712,585	114,229	5,885	751,672	1,637,761

Source: Vũ 2013.

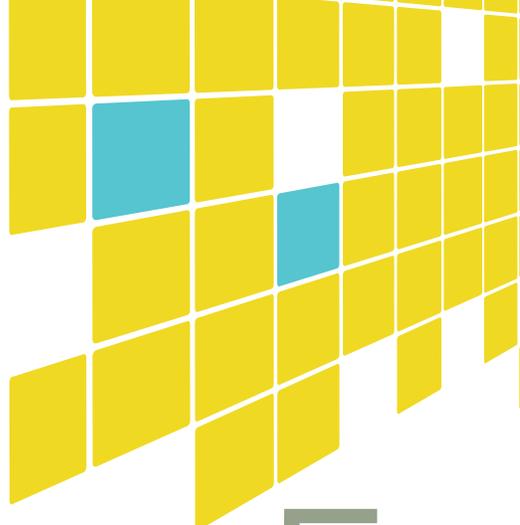
<sup>4</sup> Nước thải từ chăn nuôi làm ô nhiễm nước sông? <http://www.haisontq.com/tin-tuc-su-kien/tin-tuc/613-nuoc-thai-tu-chan-nuoi-lam-o-nhiem-song.html>. Access on 01 March 2016.

level for household farms and 21 times for large-scale commercial farms (Phùng et al. 2009). Another study in the Ba Vi dairy farms in 2012 showed that the air contamination level was 64–74 times higher than the permitted level (Lê 2012). According to some local newspapers, the risk of pollution of the surrounding areas of the TH dairy farms (in Nghe An) was very high, especially during heavy rains and typhoons at the end of summer. A journalist estimated that around 600 households had been affected by pollution from the TH farms in 2013, which involved pollution of fishponds, rice fields, and underground water (Duteurtre et al. 2015).

**Data and research on the current pollution situation related to livestock farming in Vietnam are limited.**

Different types of feeding practices result in different manure composition and variations in the quality and quantity of gasses produced in biogas digesters. Beside high concentrations of nutrients such as nitrogen and phosphorus, commercial feeds also contain growth hormones, antibiotics, and some heavy metals. Ingested nutrients and heavy metals in animal manure can pollute local land, water bodies, and air quality if they are discharged without treatment at volumes greater than the carrying capacity of the receiving ecosystems (Thi Thien Thu et al. 2012).





# SOCIOECONOMIC IMPACTS

## 5

In addition to the impacts on water, soil, and air environments, animal wastes also result in significant socioeconomic impacts.

### 5.1 Impacts on human health

**Livestock production has an impact on human health through the contamination of surface water, groundwater, soil, and air.** Animal manures and other farm effluents (including dead animals) contain many types of viruses (that is,  $H_5N_1$ ,  $H_1N_1$ ), bacteria, parasites, and so on, which can be transmitted to humans and may cause serious human diseases or pandemics. They can survive in water and soil environments for a few days or months. Waterborne diseases such as cholera are caused by eating foods or drinking water contaminated by animal wastes. One of the serious airborne diseases is bird flu caused by the highly pathogenic Asian avian influenza A ( $H_5N_1$ ) virus. In 2003, poultry were affected by the  $H_5N_1$  epidemic, which led to the mass culling of 44 million birds. The  $H_5N_1$  virus was later transmitted to humans and caused more than 100 human fatalities between 2003 and 2008. In addition to diseases caused by viruses, bacteria, and parasites, animal wastes and farm effluents also contain various amounts of feed and chemical residues, which may cause water pollution if not properly treated. The impact on public health depends on the level of contamination of food or drinking water, gender, hygiene conditions, and the method of waste treatments (Huynh et al. 2010).

**Despite clear evidence of the negative impacts of livestock wastes on public health, no comprehensive studies have been carried out on these aspects so far.** Due to lack of information, most people are still not aware of all the risks associated with improper management and treatment of animal wastes. For instance, a recent study showed that the main reason for farmers to build biogas digesters is because they wanted to reduce the problems of bad odor and flies (Huong et al. 2014a).

Many farmers are not aware that biogas effluents are not yet safe to be discharged directly to water bodies, which will be used for supplying drinking water, or to be applied directly on vegetables, which may be consumed raw (Huong et al. 2014b). In fact, biogas digesters only helped reduce *E. coli* concentrations by 1 to 2 log units to  $3.70 \pm 0.84$  *E. coli* (log 10) cfu/mL in effluents as compared with raw slurry. Biogas wastewater samples were still found positive with some pathogens harmful to humans and exceeded national standards for wastewater (Bản 2013).

## 5.2 Impacts on animal health

**Animal waste management is also important for animal health itself.** Proper animal management practices lead to better sanitation, which in turn can also prevent spreading of animal diseases. Inadequate sanitation can create a source from which infectious diseases can spread, for example, avian influenza and pig reproductive and respiratory syndrome (PRRS).

**There have been few studies on the impacts of animal waste management practices on animal health, although from the technical point of view, good hygiene and sanitation contribute to good animal health and increased productivity.** It is telling that the Livestock Competitiveness and Food Safety Project (LIFSAP) undertook integrated management measures that included good waste management practices, for instance. After five years of implementation, the project reported a reduction in mortality rate of pigs and poultry from 15 percent to 11.8 percent, and fattening times for pigs and poultry shortened from 136 days to 118 days and 66 days to 58 days, respectively (LIFSAP 2015).

## 5.3 Antimicrobial resistance

**There is anecdotal evidence that abuses of antibiotics in animal feeds has caused increased antimicrobial resistance over the years.** Over 45 types of antibiotics are reported to be widely used in livestock production

in Vietnam, of which more than 17 types of antibiotics are used in commercial farms and 15 antibiotics are used in pig and poultry feed (Dương and Nguyễn 2105; Pham Kim et al. 2013). A recent project report showed that 42 percent of Vietnam's population carry drug-resistant bacteria, a high rate when compared to other countries (SATREPS 2012–2017). One study showed that *E. coli* isolated from Colibacillosis in pigs was resistant to many kinds of antibiotics, such as *enrofloxacin* (47.2 percent), *ciprofloxacin* (33.3 percent), *norfloxacin* (40 percent), and *erythromycin* (86.6 percent) (Khanh 2010). About 80.1 percent of isolated *E. coli* and 77.5 percent of *Salmonella* spp. were found to be resistant to at least one type of antibiotic; 61.5 percent of *E. coli* and 60 percent of *Salmonella* spp. were resistant to two (or more) types of antibiotics (Phường et al. 2008).

## 5.4 Economic impacts

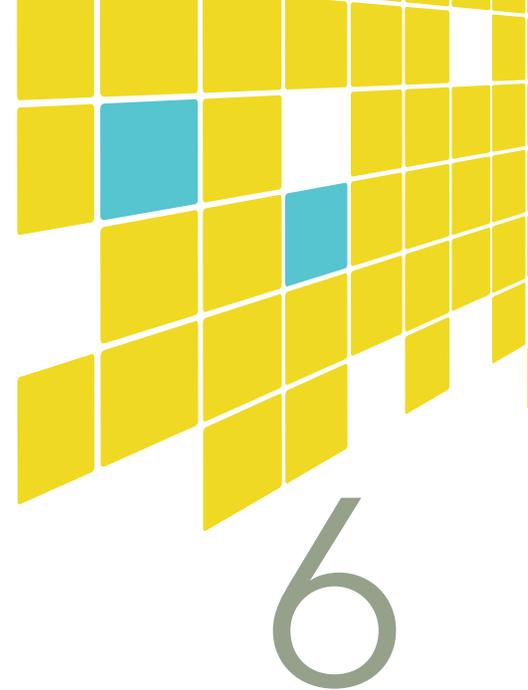
**The economic costs and benefits of livestock production are closely tied to the way in which livestock wastes are managed and treated.** Livestock wastes are good resources of organic fertilizers and can substitute inorganic fertilizers if they are properly handled, treated, and used appropriately on crops (Chau 1998). However, if they are not properly managed, they not only cause pollution of water, soil, and air environments but also result in serious impacts on public health. These either directly or indirectly result in economic losses for farmers themselves, for local nearby residents, and for the whole society.

**There have been few cost-benefit analyses of livestock waste management at the national level.** In Vietnam, livestock production generates around 80 million tons of manure and waste per year, of which around two-thirds (51.2 million tons) are treated and recycled as fertilizers for local farmers. This apparently has not only saved significant production costs for farmers but also helped maintain soil fertility of their land and reduce land degradation. However, as of 2015, over one-third of generated wastes (about 28.8 million tons) were being discharged freely, causing various degrees of pollution of the local environment. This



on-farm practice is not only wasting good resources of fertilizers but also costing the society for cleaning up and rehabilitating local damaged ecosystems and polluted environments. It is widely known that once an ecosystem has been damaged, biodiversity lost, environment polluted, and public health affected, it is extremely difficult to restore and it is also costly. Although it is difficult to quantify these impacts, more research is definitely required to draw more public attention and to develop preventive systems to mitigate the anticipated risks. Unfortunately, at present, few data are available and few studies have been conducted at the sector level on these issues. However, there is no doubt that every year, the government has to spend a significant part of its scarce budget on public health care and cleaning up locally polluted hot spots. Local residents spend greater amounts of their tight family budgets on health care related to the diseases caused by livestock wastes.





# DRIVING FACTORS

## 6.1 Trends of production and waste management

**Livestock is one of the fastest growing subsectors in Vietnam's agricultural economy, and demand for livestock products continues to increase.** To meet this increasing demand, the number of medium and large-scale farms is likely to grow in the years to come. In addition, government policies are reinforcing this trend by providing financial support to smallholder farms to expand their production scale. This shift will result in greater volumes of animal wastes. In the transformation from smallholder to intensive and large-scale livestock systems, livestock producers are facing a number of constraints, such as limited knowledge and skills in management practices, including diseases and waste management practices, limited land available for expanding livestock-raising area and for waste treatment, and limited access to credit. With these constraints, it is highly likely that producers will compromise the standards of waste treatment and management to devote their scarce private resources for other economic activities.

## 6.2 Constraints in adopting better livestock waste management

**A number of factors affect farmers' adoption of improved animal waste management practices, including production scale, farming and other land availability, access to extension systems, income levels, and family labor availability.** A greater percentage of large-scale farms adopt waste management practices than smallholder farms because they have strong financial and technical capabilities to construct waste treatment facilities to comply with the requirements. However, in many cases, due to high intensification and land availability constraint, some large-scale farms were not able to treat all the wastes. This is commonly observed in intensive pig and poultry farms in big cities and nearby such as Hanoi, HCMC, Dong Nai, and Thai Binh. The most bothersome problems observed in these farms include noxious odor and an abundance of flies concentrated in the areas.

**It is important to note that most farmers know that if livestock wastes are not properly handled, they would pollute their environment and affect human health.** However, smallholder farms are facing more constraints in adopting waste treatments. Among different livestock waste management practices adopted by smallholder farms, biogas digesters may require the greatest level of capital investment. Other methods such as composting or fishponds require less investment. Regardless of manure treatment methods, investment in environmental protection is an additional burden, which will increase production costs and reduce farming profits, at least in the short run. In the context of weak enforcement in environmental protection at local levels, many farms just want to avoid animal waste treatment to reduce their investment expenses as much as possible.

### 6.3 Lack of incentives for adopting improved livestock waste management

**There is potential for Vietnam to increase its use of organic fertilizers produced from livestock wastes for land reclamation and for agricultural crops.** However, the present demand for organic fertilizers is still low in domestic markets. This is partly because of the convenience of using inorganic fertilizers (in transportation, storage, the speed of results, and so on). Other factors such as the high costs of treatment facilities, collection, storage, and transportation (due to the bulky volume of livestock wastes) also keep the price of organic fertilizers high compared to inorganic ones.<sup>5</sup> Few private investors are willing to invest in livestock waste treatment to produce organic fertilizers for commercial purposes.

**When the environmental enforcement at local levels is weak, there is no incentive for smallholders to comply with the environmental standards, especially if they find that their neighbors are not complying.** In smallholder farms with a few animals, farmers traditionally collected and recycled animal

wastes as fertilizer for their crops and fishponds. Due to increasing market competition, many farmers had to increase their herd sizes, which led to greater volumes of manure being generated than those they could handle. Some farms had the financial capacity and invested in biogas digesters to treat their excessive wastes and produce gas for home consumption. Some who could not afford digesters decided to discharge their wastes into the environment without treatment. When one person can do it, other people follow.

### 6.4 Low social pressure

**Social pressure for farmers to better manage and treat livestock wastes before disposing of them remain low.** Bad odors from livestock wastes draw more public attention than soil and water pollution because the latter is less visible, and in most cases, people cannot make scientific measurements to demonstrate its presence. In addition, the impacts of soil and water pollution are more gradual, such that most people cannot easily recognize them. The capacity of the environmental divisions at the district level is weak. Environmental monitoring of agricultural activities and law enforcement in rural areas are almost absent.

The bad odors generated by densely pig-populated areas, such as the Ngoc Lu commune (Ha Nam Province), the Dong Trung commune (Thai Binh Province), the Gia Tan and Song Trau communes (Dong Nai Province), and the Vinh Loc commune (HCMC), generate a great deal of complaints by, and even social conflict among, commune dwellers. Government response to these has been minimal, however. Recently, more farmers have built biogas digesters to reduce odor problems; however, biogas effluents are not yet safe to be discharged directly into the environment. To meet the national environment standards for wastewater, biogas effluents need further treatment. However, most farmers are not aware of that, and they also do not have the facilities or conditions to implement further treatment for biogas effluents.

<sup>5</sup> In terms of nitrogen, organic fertilizer is more expensive than synthetic fertilizer, but in terms of weight, the reverse is true.

**There is little control and planning of smallholder livestock farming in rural areas.** So far, this part of the sector has developed spontaneously, driven by economic factors that are outside the government's control. There is also lack of participation by community-level stakeholders (that is, villagers/farmers, local authority, NGOs, and so on) in planning, monitoring, and enforcing laws especially as related to livestock waste management plans.

## 6.5 Conflicting policies in favor of livestock intensification

Despite weak capacity in environmental enforcement, government policies continue to promote more investment in and more intensification of livestock production. This is fueling the generation of ever more livestock waste and pollution.

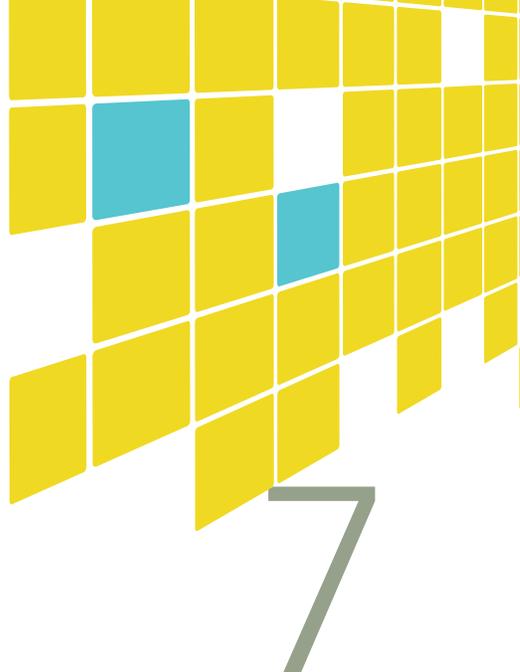
**In 2014, a new government policy committed to improving the efficiency of smallholder livestock producers during 2015–2020 and to promoting the intensification and industrialization of the livestock sub-sector through the development of large-scale farms.** The package of incentives includes subsidies for certain animal breeds and animal waste management investments (biogas and bio-mats).

**In 2013, the government promulgated an incentive policy for enterprises investing in agriculture in rural areas.** According to this policy, if households and businesses invest at regular scales of 1,000 pigs; 500 buffaloes, cows, goats, and sheep; 200 high-meat-yield cattle; or 500 high-yield buffaloes, they will receive VND 3–5 billion per project to invest in infrastructure for waste management, transportation, utilities, buildings, grassland, and equipment. In addition, when importing dairy breeds, the investor receives a 40 percent reduction in import duties. However, when the policy was implemented, it was not attractive because of its complicated procedures and paperwork. In addition, smallholders were unable to afford the capital investment required for the scale of their operations.

**The government has also tried to promote the concept of livestock zoning/LPCs to relocate livestock farming within residential areas to sparsely populated areas.** In the planned livestock zoning/LPCs, the government has developed public infrastructure (that is, electricity, water, and so on) to support livestock farming. This so far is seen as an encouragement than a compulsory policy. There were some pilots on this recently in Dong Nai, Hai Phong, and so on. Some new investors have come to invest in these zones; however, few existing small farms from residential areas have actually relocated their farms to move into these zones.

**Rather than try to strictly monitor and enforce compliance with environmental standards, the government has been trying to provide incentives for farmers and agribusinesses to construct waste treatment facilities (that is, small lump-sum grants of about US\$150 for each biogas digester constructed).** In practice, this incentive policy has not worked well, however, because the incentives are relatively small compared to the actual costs of waste treatment facilities. Driven by market forces and increased competition, the number of smallholder farms has declined considerably in recent years and these farms have been replaced by larger farms. It is urgent that the government better enforce environmental standards right from the beginning (from the time of registration, planning, and so on) as increasing numbers of large-scale farms emerge and the sector intensifies.





# INTERVENTIONS

## 7.1 Policies and regulations on livestock waste management

**In 2005, the Environmental Protection Laws were passed, clearly laying out the obligations and responsibilities of organizations, households, and individuals for environmental protection.** Also in 2005, the Department of Livestock Production (DLP) was established under MARD with the primary mandate to monitor national livestock production and environmental issues associated with the livestock production including livestock waste management. One year later, the government issued a decree providing detailed guidance on the implementation of the Environmental Protection Laws. According to these legal documents, large-scale livestock farms with more than 1,000 animals or 20,000 poultry birds are required to carry out an environmental impact assessment (EIA) before their establishment, to ensure that they will adequately manage environmental pollution. For small-scale and smallholder farms, they have to prepare and submit an Environmental Protection Commitment report, a simple form of an EIA report. The Environmental Protection Commitment report is registered at the District People's Committee or Commune People's Committee level if it is authorized.

**National standards for wastewater discharged from livestock farms have been issued by the Ministry of Natural Resources and Environment (MONRE) but they are too stringent for farms to follow.** These standards are based on industrial livestock farms and are even more stringent than those of more industrialized nations such as Thailand, Japan, and Korea. These standards are counterproductive because they discourage farms from adopting waste treatment systems.

**Although the national effluent standards exist, the enforcement of and compliance with these standards in practice are very weak.** Many farms just install a biogas digester as a symbol of treating livestock wastes to reassure local authorities, regardless of whether they are meeting environmental standards or not. In many cases, when livestock waste volumes are excessive, they are dumped outside without treatment. These violations are known by local villagers but are rarely caught by local authorities unless there are serious complaints. Insufficient enforcement is

mainly due to institutional weaknesses coupled with a lack of human and financial resources for monitoring operations.

**In 2008, MARD promulgated the Good Animal Husbandry Practices, which encourages producers, regardless of scale, to apply good practices to prevent risks from disease infection and to improve product safety and quality as well as human health and environment.** The government also developed some projects (LIFSAP and the Vietnam Avian and Human Influenza Control and Preparedness Project [VAHIP]) to support farmers in adopting good animal husbandry practices. So far, it is a voluntary adoption process.

A more detailed list of laws and regulations is shown in the Annex.

## 7.2 Technologies locally available to manage livestock wastes

**Current livestock management practices are diverse.** These vary along with (a) housing systems and their location, (b) cleaning practices (separation or mix of liquids and solids), and (c) treatment practices (biogas, composting, and manure sale). According to the DLP survey in 2013 (DLP 2015b), on average, only 6.3 percent of the intensive farms surveyed did not use any manure treatment while it was 37.3 percent for smallholder farms; 31.8 percent of intensive farms surveyed had biogas tanks, while only 4.1 percent of the smallholder farms had biogas tanks; one-fourth of the surveyed intensive farms got rid of manure (mainly pig manure) by selling them, while it was only 7.6 percent for smallholder farms. A small percentage of both intensive and smallholder farms used the manure for farming fish.

**Biogas.** Today, biogas is the most popular technology in rural areas that helps mitigate environmental problems caused by animal wastes and converts waste into energy for home consumption. In fact, biogas digesters have been used in Vietnam for several decades, but in the past 10 years, the technology

developed more strongly owing to the government's financial assistance programs providing incentives for more farmers to adopt this technology. In 2009, the government granted up to 25 percent of the cost for the construction of a new biogas digester, then reduced it to 10 percent in 2011 and 2012 (about VND 11 million for a biogas digester of 11 m<sup>3</sup>). As a result, a total of 500,000 biogas digesters have been built in the whole country in this period, of which 176,000 biogas digesters have been financed by the four main sources/projects, namely SNV-Netherlands, LIFSAP, the Quality and Safety Enhancement of Agricultural Products and Biogas Development Project (QSEAP), and the Low Carbon Agricultural Support Project (LCASP). The advantages of this technology include the following: (a) it helps reduce offensive odor, (b) biogas effluents can be used for fishponds and agricultural crops, and (c) gasses produced can be used for cooking and generating electricity. However, biogas digesters also have some limitations, such as requiring significant land area and high initial investment.

**Bio-mats, also known as bio-bedding, to reduce environmental pollution.** This is an advanced technology using organic materials to absorb liquid waste and bacteria to ferment manure and to reduce odor and pollution. Common materials used for bedding in pig and poultry farming include rice husks, sawdust, coconut fiber, and fermenting bacteria. The advantage of this technology is that farmers do not have to clean the housing facility daily. This helps reduce labor and costs. According to a DLP survey, in 2013, around 752 livestock farms and 61,449 livestock-raising households were using this technology, mainly in chicken production (DLP 2015b).

**Composting.** This is the simplest technology, which mixes manure and wastes with shredded plant matter. Rich in nutrients, compost is used in gardens, landscaping, horticulture, and agriculture. The compost itself is beneficial for the land in many ways, including as a soil conditioner and a fertilizer. In ecosystems, compost is useful for erosion control, land and stream reclamation, and as landfill cover. The advantage of this technology is to help reduce environmental pollution and create an organic fertilizer for soil and plants. Most small-scale livestock

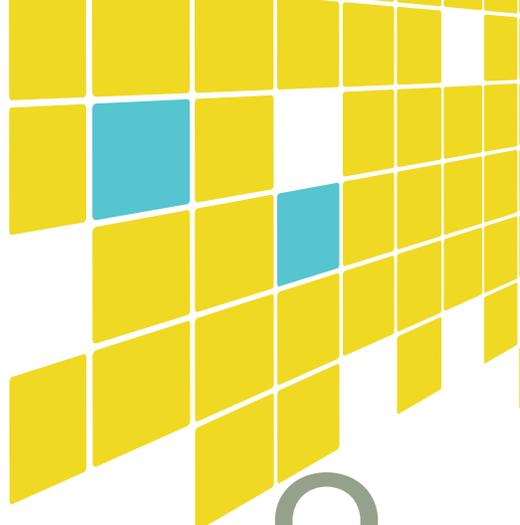


households are using composting technology to recycle wastes and agricultural by-products on their farms to produce organic fertilizers for their own uses. Large-scale farmers produce large volumes of manure which could be composted, but this does not happen because the market for compost is not developed.

**Garden-fishpond-livestock system (*Vuon-Ao-Chuong* [VAC] in Vietnamese).** The integration of the garden, livestock, and fishpond is called the VAC system in Vietnam. This integrated farming system is managed by families. In this system, pond water is used for irrigating the garden; pond mud is annually removed and used as a fertilizer for fruit trees; and livestock manure is used as fertilizer for crops and as feeds for fish. This system is only suitable for small-scale livestock production with a small amount of animal wastes released every day.

**Various types of technologies are locally available and being used by farmers.** However, the level of adoption and adoption rate are dependent on their financial capacity, labor and skills, farm sizes, animal concentration, and, most importantly, the environmental enforcement capacity of local governments.





# KNOWLEDGE AND DATA GAPS



## 8.1 Knowledge gaps

There have been few studies on pollution due to livestock farming in Vietnam so far. Based on the findings from the present study, the following knowledge gaps have been identified with regard to pollution in relation to livestock development.

### Technical

- Animal housing types in relation to waste management practices and pollution levels, including new housing designs with a pit recharge system and concrete floor
- Environmental impacts by different livestock farming systems, including scale and geographical distribution with a focus on pig and dairy cattle-populated provinces
- Quantifying concentrations of pollutants (that is, nutrients and pathogens) discharged from livestock farms leaching into recipient soils, water bodies, and groundwater
- Impacts of livestock waste pollution on public health and environmental health

### Economic

- Cost-benefit analysis of different waste management options (that is, biogas, bio-fertilizer, composting, and so on) by regions, farm types (animal species), and farm sizes (small/medium/large scale)

## Policy

- Strategies to effectively increase compliance with existing environmental protection policies, especially those relating to surface water and groundwater quality and bad odor, and bans on large-scale pig and dairy cattle farms in highly populated areas

## 8.2 Data gaps

The following data gaps have been identified:

- Amount of pollutants discharged into the environment and breakdown by animal species, farm size, and region
- Quantitative data on the levels of water pollution, air pollution, soil pollution, and product contamination caused by livestock farming
- Data on socioeconomic impact of livestock waste pollution (that is, illness, premature death, food safety violations, product rejections, lost revenues of producers, and so on)
- Official data on livestock population by livestock system (that is, household and industrial farms)
- Official data on the dynamics and changes in the number of farms and farm sizes<sup>6</sup>
- Systematic monitoring of data on livestock farms and associated environmental data in provinces and regions

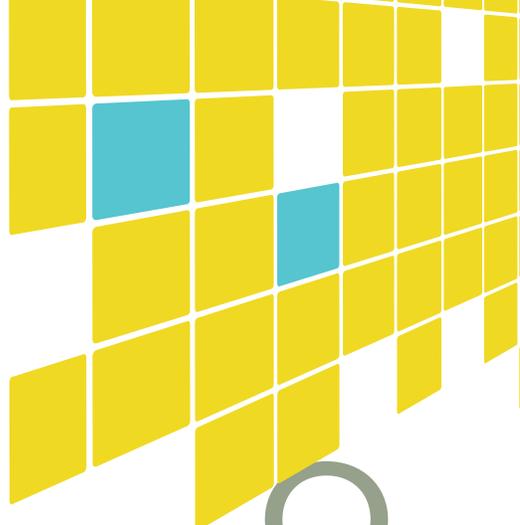
## 8.3 Hot spots deserving in-depth case studies

- Pig farms in Thong Nhat and Trang Bom Districts of Dong Nai Province. These are the

main pig production areas of Dong Nai Province. At present, many pig farms in Gia Tan commune discharge pig wastes into irrigation canals, causing damage to fruit trees in nearby gardens. In Song Trau commune, the majority of pig farms are located near a river and discharge wastes into it. Many rice fields, fishponds, and gardens around those farms have been abandoned because of flooding by pig wastes.

- Pig farms in Binh Chanh District of HCMC. A lot of pig farms in Vinh Loc A and Vinh Loc B communes are discharging wastes directly into canals and lakes. It not only causes water pollution but also emits a bad odor. Flies and mosquitos affected the lives of thousands of local people.

<sup>6</sup> Note that statistics reported in this paper are mainly academic estimates.



# CONCLUSIONS AND RECOMMENDATIONS

## 9

### 9.1 Key takeaways

1. In the past decades, livestock has been one of the fastest growing agricultural sub-sectors in Vietnam. In 2015, it contributed around 32 percent of gross agricultural output. Semi-industrial and industrial livestock production accounted for 64.2 percent of the sub-sector's total output; smallholder and small-scale production accounted for the remainder.
2. Livestock production has rapidly responded to the growing demand for meat, milk, and eggs in Vietnam during the last decades. As of 2015, over one-third (36 percent) of livestock manure was discharged directly into the environment without proper treatment (40 percent of smallholder farms and 16 percent of intensive farms). Given the trends of increasing production and intensification, waste management problems will continue to increase and become more serious in the next decades if government at all levels does not implement effective strategies to manage these better.
3. Pollution from livestock farms mainly comes from manure, feed, drugs, and chemicals. When discharged into the environment, they pollute soils, surface water, groundwater, and the air. There has been local evidence of environmental pollution caused by wastes discharged from livestock farms, although few quantitative data are available on the degrees of soil, surface water, groundwater, and air pollution, or their impact on ecosystems and public health.
4. Another serious concern is the use of antibiotics in livestock farming. Over 45 types of antibiotics are reported to be widely used in livestock production in Vietnam. Around 60 percent of feed samples from pig farms contained at least one type of antibiotic from the tetracycline and tylosin groups. There is little

doubt that the abuse of antibiotics will lead to accelerated microbial resistance. Unfortunately, few empirical studies have been carried out on this in Vietnam to date.

5. The total amount of animal manure generated in the country is around 80 million tons per year. Pigs account for 30 percent, poultry 29 percent, cattle 23 percent, and buffalos and other animals 18 percent. In terms of geographical distribution, the region that generates the most livestock waste is the RRD, followed by the SE, and the MRD. Some of the provinces that generate the most pig manure per square kilometer are Thai Binh (598 tons per km<sup>2</sup>), Ha Noi (390 tons per km<sup>2</sup>), and Dong Nai (219 tons per km<sup>2</sup>).
6. Some efforts have been made by the central government to promote the establishment of livestock production zones in each province. The main purpose of this model is to shift production from densely populated areas to sparsely populated ones. The government is financing the development of basic infrastructure for production and waste management in those areas. While this is a good approach in principle, the reality is that farmers face a number of constraints that have impeded implementation. Constraints relate to land availability, the (low) accessibility and (high) costs of labor, access to inputs (feeds, vaccines, and others), transportation, and marketing channels. At the time of writing, livestock production zones are being piloted in certain provinces, with initial financial support coming from government projects. No evaluation has been carried out as they are still at an early stage and results are not yet observable.
7. Pig farms are the largest source of livestock waste-related pollution in the RRD, SE, and MRD regions. Large-scale pig farms tend to be located near major cities, such as Hanoi, HCMC, Dong Nai, and Thai Binh. The media have often been the first to report the pollution hot spots that the development of this sub-sector has created, while public environmental monitoring and enforcement remain weak. Significant investment on the part of the government is needed and will be needed to address soil, water, and air pollution in these places. Strong cooperation on the part of producers will also be key.
8. There is a big gap between what is required by national standards for wastes and wastewater management by livestock farms and on-the-ground realities. The institutional capacity for monitoring and enforcement at the local level is generally weak. Low social pressure, little regulatory enforcement, high investment costs, and inadequate incentives are key reasons for the low adoption of improved waste management practices, especially in small-scale farms. Even for those that have already constructed biogas digesters, there is no monitoring to verify if the biogas effluents meet the standards before they are used as fertilizer for crops or discharged into the public environment.
9. The government's policy to increase livestock production and encourage intensification presents a dilemma in light of the sector's low capacity for waste handling, treatment, and management. In the current environment, however, it is unlikely that waste management will improve in the short term. Impediments include overlapping responsibilities of the environmental and agricultural ministries with respect to livestock waste monitoring, the lack of technical capacity and financial resources for effective monitoring at the local levels, and the failure to punish violators in a timely fashion. Bad waste handling and management practices will not only increase water, soil, and air pollution and impose greater risks on public health, but also reduce the competitiveness of Vietnam's products in the domestic and international markets. Such impacts are huge and cannot be ignored as they will affect the sector's sustainability in the long run.

## 9.2 Recommendations

Based on the above findings, the following recommendations are suggested:

1. MARD can coordinate with its research institutes and technical departments to carry out additional studies to fill in the knowledge and data gaps identified in section 8 of this report.
2. MARD can coordinate with MONRE to review and clarify the responsibilities of all concerned agencies that are responsible for environmental monitoring and enforcement at all levels. In addition, they need adequate human and financial resources to effectively implement their functions. The question of enforcement requires greater attention and needs to become an integral part of government incentive programs.
3. In the process of improving livestock waste management, the government's monitoring approach would benefit from reform. Instead of monitoring individual small producers, the government can help to organize them into production groups or farmer organizations (FOs) and help these develop and implement their own community-based waste management plans, with community participation in monitoring and enforcement. This approach will help create peer pressure among farmers to adopt good waste management practices. Where appropriate, the government could support FOs to develop collective infrastructure for storing and treating livestock wastes at the communal level and assist them in marketing the treated products as organic fertilizer. In some cases, these operations could be linked to government land reclamation programs.
4. Even as it extends more incentives for adopters, the local government could be stricter with violators. Depending on the level of violations, different types of punishments or fines could be applied to force all livestock producers to comply with environmental protection laws. The central government could also do more to hold local

governments accountable for pollution in their area, while providing more incentives for those demonstrating good performance.



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# ANNEX

**Table 4. Main legal documents related to livestock pollution**

No.	Legal Documents	Main Contents
1	Environmental Law No. 52/2005/QH11, dated 29 November 2005.	Provides clear obligations and responsibilities of organizations, households, and individuals for environmental protection. Article 14: Objects that are subject to strategic environment assessment reporting. Article 18: Objects that are subject to preparation of environmental impact assessment reports. Article 19: Preparation of environmental impact assessment reports. Article 20: Contents of environmental impact assessment reports. Article 24: Objects that are subject to environmental protection commitments. Article 25: Contents of environmental protection commitments. Article 26: Registration of environmental protection commitments.
2	Decision No. 3065/QĐ-BNN-NN, dated 7/11/2005	Provides regulations on bio-security-related conditions of the areas to operate production, hatchery, transportation, slaughtering, and marketing of poultry and poultry products.
3	Decree No. 80/2006/ND-CP by the Prime Minister, dated August 9, 2006	Provides details on and guides the implementation of a number of articles of the Law on Environmental Protection. Addresses activities related to agriculture, including EIA, waste management, and rural environmental protection.
4	Decision 1504/QĐ-BNN-KHCN dated 15/05/2008	MARD promulgated the Good Animal Husbandry Practices for Poultry, which encourages poultry producers, regardless of scale, to apply good practices to prevent risks from diseases and infection and to protect poultry product's safety and quality as well as human health and environment.
5	Decree No. 21/2008/ND-CP by the Prime Minister, dated February 28, 2008	Modifies certain articles of the Decree No. 80/2006/ND-CP dated August 9, 2006. According to these legal documents, large-scale livestock farms with more than 1,000 animals and 20,000 poultry have to carry out an EIA before building to contribute to reducing environmental pollution from livestock operations. Small-scale, smallholder farms have to submit an Environment Protection Commitment Letter, a simple form of an EIA report. The Environment Protection Commitment Letter is registered and the District People's Committee or Commune People's Committee is authorized to provide this kind of 'certificate'.
6	Circular No. 07/2007/TT-BTNMT of MONRE dated July 3, 2007	Guides the classification of polluting establishments to be addressed and guides decision making regarding this list of polluting establishments. Agricultural production establishments causing environmental pollution are subjects of the circular.
7	Circular No. 12/2006/TT-BTNMT of MONRE dated December 26, 2006	Provides guidance regarding professional conditions and procedures for documenting, registering, licensing, and coding in hazardous waste management. Agricultural production establishments generating hazardous waste are subjects of the circular.
8	Decree no. 59/2007/ND-CP dated 09 April 2007	Provides regulations on management of solid waste and the rights and obligations of entities related to solid waste.
9	Decree No. 79/2008/ND-CP, dated 18 July 2008	Provides regulation management system, inspection, and testing of food safety. Article 8, Section 2: Inspection contents of food safety in agriculture and rural development.
10	QCVN 40/2011/BTNMT	This technical standard for animal wastewater refers to Vietnam's technical standard on industrial wastewater (the former is QCVN 24/2009/BTNMT and the latter is QCVN 40/2011/BTNMT). According to these standards, for wastewater, regulations are that BOD5 should reach 30 mg/L and COD should reach 75 mg/L (very low compared to industrialized nations and Thailand). This discourages livestock farms to adopt treatment systems.
11	Circular 04/2010/TT-BNNPTNT QCVN, 2010. MARD issued the Vietnam National Technical Regulation Conditions for Biosecurity of Pig Farms. dated 15/01/2010 of MARD	
12	Circular 27/2011/TT-BNNPTNT dated 13/4/2011 of MARD	Chapter 2 contains provisions on conditions of waste disposal, ensuring environmental sanitation in livestock farms.
13	Decree 179/2013/ND-CP, dated 14 November 2013	Provides regulations on administrative sanctions in the field of environmental protection.
14	Decree No. 25/2013/ND-CP, dated 29 March 2013	Provides regulations on environmental protection charges for wastewater.
15	Decision 985 / QĐ-BNN-CN dated 09 May 2014	Revises and promulgates state management documents on livestock breeds and animal feeds, livestock environment associated with climate change. Promulgates regulations and criteria on livestock breeds, animal feeds, and livestock environments, as well as on disease prevention and veterinary hygiene.

Table 4. Main legal documents related to livestock pollution

No.	Legal Documents	Main Contents
16	The Law on Environmental Protection 55/2014/QH13	Dated June 23, 2014. Article 69. Concentrated livestock zones must have a plan for environmental protection and meet the following requirements: a. Ensure environmental sanitation for residential areas. b. Ensure collection and treatment of wastewater and solid waste; provide regulations on waste management. c. Cages and farms to be cleaned periodically; ensure prevention and response to epidemics. d. Bodies of animals that died from disease should be managed according to the regulations on hazardous waste management and hygiene and disease prevention.
17	Circular No. 50/2014/TT-BNNPTNT dated December 24, 2014	Amends the Circular No. 66/2011/TT - BNNPTNT detailing Decree No. 08/2010/ND-CP on the management of animal feeds. Revises and promulgates state management documents on livestock breeds and animal feeds, and livestock environments associated with climate change. Promulgates regulations and criteria on livestock breeds, animal feeds and livestock environments, as well as on disease prevention and veterinary hygiene.
18	Decree 18/2015/NĐ-CP, dated 14 February 2015.	Provides regulations on environmental protection planning, strategic environmental assessment, EIA, and environmental protection plan.
19	Decree 19/2015/NĐ-CP, dated 14 February 2015.	Provides detailed regulations on the implementation of some articles of the Law on Environmental Protection.
20	Decree 38/2015/NĐ-CP, dated 24 April 2015	Provides regulation on the management of waste and scraps, including hazardous waste, domestic waste, general industrial solid and liquid waste, wastewater, industrial emissions, and special waste, and environmental protection in scrap imports.
21	Circular No. 23/2015/TT-BNNPTNT, dated 22 June 2015	Provides regulations on management of products used in improving the environment in livestock and aquaculture production.
22	Decision No. 3194 / QĐ-BNN-CN dated August 11, 2015	Adds biological products including biological padding to the list of products that can be used to improve the breeding environment.
23	Circular No. 06/2016/TT-BNNPTNT dated May 31/ 2016	Provides the list of permissible antibiotics as growth stimulants in livestock and poultry feeds in Vietnam and contents thereof, avoiding ingredients that are detrimental to the environment.
24	Circular no 27/2016/TT-BNNPTNT dated 26 July 2016	National technical regulation on animal feed specifying maximum levels of mycotoxins, heavy metals and microorganisms in compounded feeds for livestock.
25	Circular No. 01/2017 / TT-BNPTNT dated 16/01/2017	Supplements the list of chemicals and antibiotics that are banned from importation, production, trading and use in cattle and poultry feeds in Vietnam, and includes toxic chemicals with detrimental effects on the environment.
26	Decision No. 397 / QĐ-CN-MTCN dated April 4, 2017	Regulation on environmental protection measures that includes measures on animal waste treatment; solid waste treatment; wastewater treatment; biogas waste treatment; and on noise from livestock farms.

Source: Government Portal. <http://congbao.chinhphu.vn/>.

### Waste management practices



Semi-industrial pig system



Smallholder pig farm



Village drainage system



Pig waste is discharged into surrounding area



Smallholder chicken flock



Smallholder cattle





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