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## **Pollution and Environmental Issues in Agriculture and the Livestock Industry: A Brief Review of the Japanese Case**

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**Abstract:** This paper presents an overview of the current conditions of livestock-related environmental problems in Japan. The former Basic Agriculture Act, which was effective between 1961 and 1999, promoted single cropping, the use of chemicals in agricultural methods, and the use of large-sized machines, which caused problems such as soil impoverishment, replant failure, chemical residue accumulation, ground water pollution, and productivity reduction. Many of these livestock-related environmental problems are closely linked to substances in livestock excreta and excessive nitrogen, which is the prime cause of concern. These problems are related to externality and can be attributed to the overuse of natural resources. In addition, the former law ignored the multiple functions of agriculture, which, in turn, diminished the positive external effects. These problems are related to externality and can be attributed to the underuse of natural resources. This condition has been improved under the Food, Agriculture and Rural Areas Basic Act (New Basic Agriculture Act). Superficially, livestock excreta and excessive nitrogen contribute to the overuse problem, but if we regard them as unused resources, they can also be categorised as factors that contribute to the underuse problem. The new act offers measures to resolve underuse problems, but these measures continue to remain inadequate to arrive at a complete solution. Therefore, in addition to the legal approaches adopted, voluntary countermeasures by agriculture and livestock farmers should also be promoted.

**Key words:** externality, livestock-related environmental problems, livestock excreta, multiple functions of agriculture, voluntary countermeasures

**JEL:** Q53, Q18

## 1. Introduction

I remembered seeing the words, "the start of cultivation and livestock farming was the first environmental damage done by humans" in some different books before.<sup>1</sup> To prove this, several books point out that the cause of the collapse of the ancient civilizations was environmental damages (following: Tainter, 1988; Brown, 2002). For example, agriculture (irrigation agriculture) was performed for the first time in the world in the ancient Mesopotamian civilization. Surplus from agriculture helped build urban civilizations, which supported the Mesopotamian civilization. Ironically, however, as the result of irrigation, salt contained in the soil increased and the yield decreased, which led to the disruption of the civilization. With regard to the Maya civilization, too, several studies indicate that agricultural environmental problems, including decreased soil fertility and soil erosion caused by slash-and-burn agriculture, were the reasons for the decline of the civilization. On Easter Island, which is famous for the moai statues and the mystery of them, the population greatly dropped because of environmental problems, namely, the destruction of forests and the soil that supported them. By the time the European civilization came in contact with the island, they no longer had the economic power to build the moai statues (Brander and Taylor, 1998, Matsumoto, 2004).

On the other hand, it has been pointed out that Japanese agriculture, forestry and fishing in the old days were very symbiotic with their natural environments. For example, Tamanoi et al. (1985) made the earliest indication of good circulation of materials in the Edo era (Murota et al., Ed., 1995). According to these two pieces of literature, the Edo era was never withered by environmental problems caused by agriculture for 250 years. The background is said to be provision of farm crops to Edo (Tokyo) and recycling of human excreta back from Edo to rural villages. Also, fishing done in Edo Minato (Tokyo Bay) helped to recycle the nutrients that had flown into the water from rivers back to the land. The same recycling done in Edo was seen in every part of Japan until about the 1950s.

As is generally known, economy grows, but its rate is not always constant. The growth rate in the Edo era is thought to have been relatively slow for a long time while rapid economic growth was achieved in the boom time starting from the 1960s. Under the former social background, agriculture could stably maintain a good relation with the environment, but in the latter circumstance it was difficult to

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<sup>1</sup> For example, Yoshimura (1986) points out that "the extinction of animals and destruction of nature had already begun in the time called the Neolithic Revolution (Agriculture Revolution)."

either maintain a stable relationship or give only positive effects. Environmental problems gushed out of the resulting fractures. Under the environmental Kuznets curve hypothesis, agricultural environmental problems may be expected to die down along with economic growth. However, there is no guarantee that things will actually go according to this hypothesis. It is necessary to grasp the present conditions of livestock-related environmental problems as well as to what solutions are being attempted and what problems are left to be tackled.

## **2. Livestock Environmental Problems**

### **2.1. Environmental Functions and Livestock Environmental Problems**

The environment gives food and habitat to humans and every living thing equally. Its functions can be divided into the ability to supply the materials and services necessary to live, the ability to absorb and purify wastes excreted as a result of living, and the ability to provide amenity of habitat. Environment is not a fixed and independent individual entity but a variable existence consisting of all the other entities surrounding an object.

Environment is the world around an entity. Therefore, a livestock-related environmental problem is a problem that occurs in the relationships between an entity in the livestock industry and the world around it. If available water resources in the area dry up because of livestock breeding, it is an example of the destruction of the environment's ability to supply. If the water gets polluted because a large quantity of livestock excreta is discharged into the river, it is an example of the destruction of the environment's ability to absorb waste. If a barn is built alone in a vast open plain, and the livestock animals that are kept there in an overcrowded condition and covered with excreta spoil the landscape and stink, it is an example of the destruction of amenity.

On the contrary, if an entity in the livestock industry appropriately uses the environment, it is a relationship in which both benefit the other. For example, if a proper number of cattle are bred in extensive pasturage, the cattle eat the meadow grass and the meadow grass gets nutrition from the excreta. It is a mutually benefiting relationship and no environmental problem occurs. If you only look at it from this description, you may argue that, in the end, grazing is still a negative activity to the meadow grass, but this is not necessarily true. If eaten, the plant grows to make up for it. It is known that biomass is higher when a plant grows this way than without being eaten. This is called excessive complementation

(McNaughton, 1984).<sup>2</sup>

In any case, an entity within the livestock industry is causing some kind of positive or negative effects to its own environment. If it is a negative effect, it may possibly be understood as a livestock environmental problem. I say "possibly" because, even though a physical problem has occurred, it may not be regarded as a problem as long as humans do not perceive it as a problem, or it is not problematic to humans.<sup>3</sup> On the other way around, an entity within the livestock industry itself is a factor of its own environment of other entities, and it is influenced by those other entities.

## **2.2. Degree of Environmental Use and Livestock Environmental Problems**

The relationship between an entity and its environment can change over time. Today, in particular, it is difficult for agriculture and livestock industries to establish stable, longstanding relationships with the environment, under the influence of social and economic changes. If the quantity of environmental use by an entity increases or decreases sharply, it may emerge as a problem.

For example, the number of dairy cattle kept per farm has largely increased. In 1955 it was 1.7 heads nationally and 2.3 heads in Hokkaido, but it jumped up to 62.8 and 101.3 heads respectively in 2008. On the other hand the number of dairy farms has been decreasing since 1960. These data show that the scale of dairy farms has expanded, especially in Hokkaido.<sup>4</sup> Thus, this has become a big problem in Hokkaido. In addition to having a greater speed of farm scale expansion than that of the rest of the country, the way to keep cattle has changed from a free-range style to an intensive one. This has created the condition where a large amount of excreta discharged from dairy farms flows out into the environment with melted snow. The amount that is beyond the absorbing capacity of the environment accumulates on

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<sup>2</sup> Kira (1952) made a similar suggestion about zoysia grassland. The survey in Aso "showed that the productivity of the zoysia grassland is very large under the condition that livestock animals constantly eat it."

<sup>3</sup> This argument is parallel to the argument of the physical pollution and economic pollution in economics. That is to say, although there is actual environmental pollution, it does not exist economically as long as it does not influence social welfare (Turner et al., 2001).

<sup>4</sup> Japanese livestock farming tries to make up for small profits by selling in large volumes, but it has been pointed out that this has resulted in a vicious circle of where scale expansion lowers profit margins, which drives the farms into further expansion (Arai, 2000, Miyata, 2004).

the bottoms of the streams around dairy farms.<sup>5</sup> This is an example of excessive use of the absorbent capacity of the environment with social and economic changes as its background.

Conversely, underuse can also be a problem. The problem of derelict cultivated land is a prime example. In 2009 the Ministry of Agriculture, Forestry and Fisheries issued a press release on the results of a nationwide survey, in which derelict farmland was divided into arable lands (green), lands that should be used for agriculture (yellow), and lands unrestorable to farmland (red) (Ministry of Agriculture, Forestry and Fisheries, 2009a). It estimated that the green, yellow and red derelict lands are 82,000 hectares, 67,000 hectares, and 135,000 hectares respectively; 284,000 hectare in total. According to the agricultural and forestry censuses of 2000 and 2005, the derelict farmland is estimated as 210,000 hectares and 386,000 hectares respectively.

Figure 2 shows the changes of expanded and converted/abolished farmland areas over several decades in order to indirectly read the long-term changes in derelict farmland. According to this, the area of converted/abolished rice field was larger than the expanded area for a long time, and the converted/abolished upland field area was larger than the expanded area from the end of the 1980s. Therefore, it can be said that in recent years conversion and abandonment of farmland has been accelerated.

In climate conditions like in Japan, derelict farmland becomes wild and overgrown. As derelict farmland tends to appear in and near the hills and mountains, it becomes the home range of wild animals once it gets overgrown with vegetation. This may bring on a vicious circle as it triggers invasion of the wild animals to the still cultivated fields around the new overgrowth, and more of these fields become derelict. This problem can be regarded as an underuse problem due to the decreasing use of farmland.

After all, problems of overuse and underuse may occur without having a long-term stable relationship between entities within and around the livestock industry and their environments. Particularly the concept of resilience is regarded as important these days. Activities of the livestock industry give disturbance but the

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<sup>5</sup> Hashimoto et al. (1999) mentioned that, in Hokkaido, approximately 70% of the livestock excreta is from dairy cattle, that the more delivered cows a farm keeps, the more difficult it is for them to recycle the excreta to their own farmland, and that a quarter of the dairy farmers who keep 100 or more dairy cattle are unable to recycle or treat the excreta.

environment has the "resilience" to return to its original condition as long as the disturbance is under a certain degree. If a disturbance beyond the resilience occurs, a big change called a regime shift may occur, and the change may be irreversible. Such cases have been reported in fields related to the agriculture and livestock industries. Eutrophication of lakes, salt damages to farmland, and destroyed coral reefs are some examples of this.

### **2.3. Reason for Environmental Problems**

From the viewpoint of economics, reasons for environmental problems are generally explained by technical externality and public goods, the characteristics that environmental goods and service have.

Technical externality refers to that fact that an individual or a company's behavior gives effects directly to other individuals and companies without making changes in the market. For example, assume a tourist who thinks a view of dairy farms in Hokkaido to be beautiful. The tourist pays for the dinner served at a restaurant attached to a dairy farm, but does not pay the dairy farmer for the beautiful scenes around. The tourist is enjoying the beautiful environment not through a market. In this way, when someone enjoys a positive effect without a market, it is called a positive externality. During the trip, the traveler's car may be filled with the unpleasant smell of excreta, or soil and sand blown from farmland may block the view and dirty the car. In this case, the tourist will not seek compensation from the farmers. When someone receives negative effects, namely, unpleasantness and inconvenience, without a market, it is called a negative externality.

The goods and services that bring such externalities have the characteristics of public goods. Borrowing the words of Shibata & Shibata (1988), the public goods can be described as the goods with the characteristics, "yours is mine (non-exclusiveness)" and "inexhaustible service" (non-competitiveness). You have to pay to get farm crops, but anyone can enjoy the beautiful scenery of dairy farms without paying (non-exclusiveness). Then, besides exceptional people, nobody will pay for it, which becomes a kind of free ride problem. If someone buys farm crops, the amount available for others decreases, but everyone can enjoy the beautiful scenery to the same extent (non-competitiveness). The same things can be said about the wastes from agricultural and livestock industries. Because of these characteristics of public goods, the problems of the externality cannot be solved without intervention by governments. The water source recharge tax and the direct

payment to farmland of disadvantageous conditions are for dealing with the positive externalities concerning agriculture, and the regulations against discharge of the excreta and drainage from agriculture and livestock industries are for dealing with negative externalities.

Attention also needs to be paid to environmental capacity as a reason for environmental problems. The environmental capacity refers to the upper limit of the quantity of goods and services that an environment can provide, or quantity of waste an environment can purify. For example, Matsumoto & Matsuyama (1995, p. 250) pointed out as the background of the environmental problems concerning the livestock wastes, "(1) because the domestic foundation of feed production is weak, the industry depends on import from other countries for most of the feedstuff; (2) the scale of a farm, especially of small and medium-size animals, has expanded regardless of the size of the land it has, and farms are located unevenly in limited areas; and, (3) livestock wastes (animal excreta) are produced in large quantities in the limited areas. This is a problem resulting from overflowing the capacity of the environment to absorb the wastes. The problem of scale expansion is as mentioned before. From the beginning, dairy farms are not distributed uniformly, but, in Hokkaido for example, there are dairy farming zones and upland farming zones. The former zones have excessive excreta while the latter zones have too little (Masuko, 2006, p. 288). Expansion of farm scale causes further excreta excess in the dairy farming zones.

### **3. Livestock Environmental Problems in Japan**

#### **3.1. Livestock Pollutions and Livestock Environmental Problems**

Depending on the range of the influence, environmental problems can be classified roughly into environmental pollutions and global environmental problems. Environmental pollution refers to local environmental problems caused mainly by business activities. Global environmental problems are those which occur on a global scale caused by any human activity. The Environmental Basic Act, Article 2, defines environmental pollution as the occurrence of damage to human health or living environment caused by pollution of air, water and soil, noise, vibration, subsidence of the ground and offensive odor, produced by business operations and other human activities. Also, it defines global environmental protection as protecting environments from global warming being caused by human activities, progress of the ozone layer depletion, marine pollution, decrease in wildlife species, etc.



In Japan, as a result of rapid economic growth, environmental pollution became a social problem in the 1960s. An extraordinary session of the Diet called "the Environmental Pollution Diet" was held in November, 1970. As a result, laws concerning agricultural and livestock industries, namely, the "Water Pollution Control Act," the "Waste Disposal Act," and the "Agricultural Land-Soil Pollution Prevention Act" were established, and the "Basic Act for Environmental Pollution Control" (established in 1967, abolished in 1993) and the "Agricultural Chemicals Control Act" (established in 1948) were revised. In this background, livestock pollution including offensive odor and water pollution from animal excreta and the outbreak of pest insects was one of the major problems. Today the pollution problems have been greatly improved in Japan. However, not all of the livestock pollution problems have been resolved. Furthermore, new global environmental problems have been occurring. These problems are now referred to as livestock environmental problems.

Here I will summarize the representative livestock environmental problems.

#### **(1) Water pollution**

Water pollution includes eutrophication of the lakes and seas along the beaches due to deteriorated water, and contamination of river and groundwater, caused by the wastes discharged from agricultural and livestock operations. With regard to cultivation, chemical fertilizers, especially nitrogen, become the main source of pollution. With regard to livestock farming, livestock excreta are the source. According to Matsuyama (1995, pp. 250-251), the nitric acid pollution caused by chemical fertilizers spreads over a large area in low concentrations while livestock excreta pollution occurs in limited areas in high concentrations. The standard has been set for the quality of water and the water waste discharged from industrial operations should be kept under this standard. However, quite a little of groundwater and well water contains nitric acid beyond the standard, and chemical fertilizers and animal excreta are said to be the sources of the pollution (Masuko, 2006, pp. 284-285).

Chemical fertilizers and animal excreta contain nitrogen. Nitrogen and phosphorus are necessary for plants to grow, and the nitrogen absorbed by the plant is converted to amino acid by photosynthesis. However, when the amount of applied chemical fertilizers or discharged livestock excreta go beyond the quantity that farm crops and herbaceous plants need, some of the extra fertilizers or discharged livestock excreta remain in the soil, and changes to nitrate nitrogen,

which is more soluble. It flows into rivers and lakes, and causes eutrophication problems. Some of the extra fertilizers and excreta is absorbed by the plant and changes to nitrate nitrogen, and remains in the plant.

The nitrate nitrogen changes to nitrite nitrogen in a human body and gets bound to hemoglobin causing hypoxia. This state is called methaemoglobinaemia. In particular, because gastric acid is weak in infants younger than three months, weak nitrate nitrogen can change into nitrite nitrogen in their stomach more easily (Ministry of Agriculture, Forestry and Fisheries, 2009b). The case of methaemoglobinaemia in infants is known as blue baby syndrome because nitrite nitrogen bound to hemoglobin causes cyanosis and the lips turn blue. The first two cases were found in the U.S.A. in 1945, and approximately 2,000 cases have been reported in North America and Europe since then. Methaemoglobinaemia has hardly ever occurred in Japan, but there were cases that a similar intoxication occurred in ruminant livestock animals in the late 1960s (Ministry of Agriculture, Forestry and Fisheries, 2009c).

## **(2) Offensive Odor**

Offensive odor is exhaled from livestock excreta and residues from slaughter and dressing facilities. Most of the complaints about offensive odor used to be about poultry farming, and, after that, about pig farming for a long time. In recent years, however, most complaints are about offensive odor from farmyard compost and cultivated fields (Department of Environment, 2002, p. 49). In the process of making fully mature compost, microorganisms decompose the odorous components, and sufficient decay by aerating can remove odor in the process of making slurry (Matsumoto & Matsuyama, 1995, p. 252). However, offensive odor can occur when these treatments are insufficient, unprocessed compost is kept in the field, or a large quantity of compost or slurry is applied to a limited area (Masuko, 2006, p. 284).

Fortunately, taking measures against an odor problem at a livestock farm is easier than in other types of industry. Many of the causative substance of the odor at livestock farms fall under the 22 specific malodorous substances, including ammonia and lower fatty acid, designated by the Offensive Odor Control Act. On the other hand, in other industries, the odor is often from sources other than the specific malodorous substances, or a combination of odors from more than one substance. Therefore, it is easier for a livestock farm than other industries to avoid the problem by observing the regulations for emission concentration of the

substances (Department of Environment, 2002, p. 18, p. 20).

### **(3) Unsanitary Insects and Animals**

Unsanitary insects give sanitary harms to people and livestock animals. Kamata et al. ed. (2001) classifies the harms by unsanitary insects into harms by ectozoan, harms by entozoan, transmission of infectious diseases and parasitosis, damages to feed, and nuisance. Insects of particular concern to livestock breeding are flies and mosquitoes. Various types of flies including house flies and blow flies are produced from animal excreta in large quantities, and become a nuisance to people and spread pathogenic organisms. Mosquitoes such as Northern house mosquitoes and *Armigeres subalbatus* emerge from ditches and clarification tanks around livestock barns.<sup>6</sup> These flies and mosquitoes sometimes fly to residential areas from neighboring livestock barns and become a nuisance and spread pathogens.

Unsanitary animals in Japan that are problematic in the livestock industry are rats. According to Oshida (2006), the harms of rats are classified roughly into sanitary harms and economic harms. Economic harms are more serious in Japan. The damages are caused by sewer rats, roof rats and house mice.

### **(4) Others**

The afore-mentioned water pollution, offensive odor and unsanitary insects were problems whose major cause is livestock excreta. In addition, the following problems are pointed out. First there are the noise problems caused by the calls of livestock animals (Ogimoto et al. 1989, pp. 138-139). Second greenhouse gas is emitted from livestock animals. 16% of the atmospheric methane is from belches of ruminants, and 5% comes from livestock excreta (Oshida, 2000, p. 203). In addition, when livestock animals, because a soil pollution has occurred, are fed with formula feed and then the excreta from them is applied to the field, copper and zinc derived from feed additives may accumulate in soil (Matsumoto & Matsuyama, 1995, p. 252). Also, it has been pointed out that offensive odor, water pollution and pest insects are produced while livestock products are processed at slaughterhouses (Ogimoto et al. 1989, pp. 138-139). Today the pollution of water supplies and water sources by *Cryptosporidium*, a protozoan, has become a problem.

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<sup>6</sup> The above is based on Kamata et al. (Ed.). (2001) and Oshida (2006).

### 3.2. Environmental Load that Occurs in Livestock Production

As mentioned before, many of the representative livestock environmental problems are closely related to livestock excreta. Excessive nitrogen is the primary cause of the problems. With regard to the quantity of load of the excreta on farmland, Moriya & Kitagawa (2007) introduces an argument by Harada (2000).<sup>7</sup> I will try multiple regression analysis below assuming the data from Moriya & Kitagawa (2007) as explained variables, and using variables that can explain the quantities of excreta load of prefectures as explanatory variables (Table 1). First I put up the numbers of cattle, pigs, and chickens as explanatory variables. As the number of these animals is larger, the load of livestock excreta is expected to be larger and the coefficient will be positive. In addition, I put up the percentage of cultivated area and the total areas of municipalities. As these percentages and areas are larger, the capacity for livestock excreta will be larger. Thus the chance of excessive nitrogen will be smaller and the coefficient is expected to be negative. High land productivity can be supposed to be the result of the application of processed livestock excreta, thus the coefficient is expected to be positive. With regard to the percentage of the labor force of the primary industries, which includes agriculture and livestock industries, the coefficient will be negative if agriculture has relatively sufficient capacity to accept excreta, and positive if the capacity is insufficient.

Table 2 shows the results of the estimate. Model 1 uses all the explanatory variables. In Model 2 the explanatory variables are removed one by one from the one with the higher p-value, and the p-values of all the remaining variables are less than 10%. The difference of the AICs of the two models is less than 1, thus which model is better cannot be decided by AICs. Most of the variables meet the afore-mentioned correlation of positive/negative coefficients. Interestingly, the numbers of beef cattle and pigs are not adopted as explanatory variables in Model 2. With regard to beef cattle, it is surmised that, as quality beef is more preferred in the market these days, more and more beef cattle are bred in more extensive areas, thus excessive problems of excreta are not occurring. With regard to pigs, there is the tendency that as the number of pigs bred increases, the load quantity of the nitrogen in livestock excreta decreases. Further studies are necessary to find out

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<sup>7</sup> Harada, Y. (2000). Appropriate management of livestock excreta and the future direction in terms of its utilization. *Japanese Society of Animal Science, the 97th Conference Symposium Proceeding, Direction and prospects of animal science studies in the 21st century*. 25-29.

the reasons for the tendency.

Here I mention two reasons that livestock excreta can become a problem. First, the characteristics of livestock management in Japan conflicts with utilization of livestock excreta. Arai (2000) points out four characteristics of livestock farming in Japan and, in his explanation of the third characteristic, he says, "the representative crop linked to livestock farming is rice... effects of linking paddy fields and livestock farms on excreta treatment is weak." In addition, in the explanation of the fourth characteristic, he points out, "If livestock farming that does not utilize soil, such as pig and poultry farming, becomes an independent business, no link with soil is created and livestock excreta is not utilized. As a result, many incompatibilities emerge. For example, fields are turned into just disposal sites of excreta and livestock farms become sources of pollution.

Second, recycling is not achieved sufficiently under the development of international trade. As mentioned before, in Japan in the old days, nutrition that flowed to the sea was recycled by fishers carrying it back to the land. Similarly, the nutrition that flowed to the sea is recycled by bears catching salmon running up rivers (Murota, 2001). This artificial and natural recycling may stop working sufficiently with the progress of international trade. According to Oshida (2006), Japan imports 95% of the feed that it uses. In other words, a large quantity of nitrogen comes from outside of the country and is discharged as livestock excreta. As a result, the quantity of nitrogen in the soil and sea is increasing year by year.

### **3.3. Environmental Load and Complaints in the Livestock Production**

As shown in Figure 3 the number of complaints about livestock pollution marked the highest 11,676 in 1973 (Higaki, 1980, p. 1), and fell after that. In recent years it has been stable around 2,500 annually. Note, however, that Okinawa is not included in 1972 and before. In 1973, when the largest number was recorded, the number of complaints for each animal was 5,549 (47.5%) for pigs, 2,502 (21.4%) for chickens, 2,401 (20.6%) for dairy cattle, 1,196 (10.2%) for beef cattle, and 28 (0.2%) for others. The breakdown of the complaints by the subjects was (multiple answers) 5,298 (45.4%) for water pollution, 8,704 (74.5%) for offensive odor, and 115 (1.0%) for others.

In the newest data, the data of 2008, the breakdown by animals is 671 (27.6%) for pigs, 473 (19.4%) for chickens, 805 (33.1%) for dairy cattle, 413 (17.0%) for beef cattle, and 71 (2.9%) for others. The breakdown by subjects is (multiple answers) 700 (28.8%) for water pollution, 1,479 (60.8%) for offensive odor, 154 (6.3%) for pest

insects, and 39 (13.9%) for others.

#### **4. Laws about Livestock Environmental Problems**

##### **4.1. Fundamental Laws about the Environment and Laws for the Lower Categories**

The Basic Act for Environmental Pollution Control (1967) was established in 1967 while pollution problems caused by businesses activities, including the four major pollution-related diseases, i.e. Itai-itai disease (1910-, Toyama), Minamata disease (1956-, Kumamoto), Yokkaichi asthma (1960-, Mie) and Niigata-Minamata disease (1964-, Niigata), were worsening with the high growth of the economy. This law played the role as the fundamental law for environmental problems until the Environmental Basic Act was established in 1993. In addition, the Agricultural Chemicals Control Act (established in 1948), the Water Pollution Control Act (1970), the Wastes Disposal and Public Cleansing Act (Waste Disposal Act, 1970), the Agricultural Land-Soil Pollution Prevention Act (1970), and the Offensive Odor Control Act (1971) deal with each category of agricultural and livestock environmental problems.<sup>8</sup>

Among these laws, the Water Pollution Control Act, the Waste Disposal Act, and the Offensive Odor Control Act are generally categorized as the laws deeply related to livestock industry. For example, the Ministry of the Environment announces every year the number of the specified business establishments based on the Water Pollution Control Act and the Act on Special Measures for the Conservation of the Environment of the Seto Island Sea (1973) and, as of the end of March 2009, the number of the specified business establishments based on the Water Pollution Control Act was 273,098. The number of the specified livestock business establishments based on the Water Pollution Control Act and the Act on Special Measures concerning the Conservation of the Environment of the Seto Island Sea is 30,380, accounting for 11% of the total number. This is the second largest number next to the hotel businesses (Department of Environment, 2009).

Livestock carcasses and excreta are defined as industrial waste in the Waste Disposal Act, and must be treated properly according to the law. It is an illegal act for a person to leave or bury a livestock carcass even on their own land.<sup>9</sup> Similarly, it is an illegal act for a livestock farm larger than a certain scale to leave (more specifically, "pile up" or "store in a hole") excreta even on their own land. It must be

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<sup>8</sup> For details, refer to Ministry of the Environment (2010).

<sup>9</sup> Refer to Chiba Prefecture (2008) for an actual case.

treated according to the Livestock Excreta Act mentioned later.

The Offensive Odor Control Act "gives proper regulation and promotes preventive measures against offensive odor produced from factories and other business sites (Article 1)" and regulates the odor based on the offensive odor specification and the offensive odor index (Article 2). When the law was established, it only regulated the emission concentration of the specific malodorous substances. However, the regulation of emission concentration is not good enough to deal with compound odors. Therefore, at the time of amendment in 1995, regulation by odor index was introduced. As mentioned before, however, the regulation of emission concentration of the substances is supposed to be able to sufficiently control livestock odor.<sup>10</sup>

The Environmental Basic Act was established in 1993 as environmental issues expanded from conventional local pollutions to the global environment, and it was recognized that not only business operations but also activities by ordinary citizens made an impact on environment. Based on Article 15 of the law, national and local governments must formulate basic environmental plans. The present Basic Environmental Plan (2006) of the national government suggests that the livestock excreta problem has not been solved sufficiently, saying, "Groundwater pollution of nitrate nitrogen and nitrite nitrogen coming from fertilizers, livestock excreta and sewage has been disclosed by the surveys of prefectural governments."

#### **4.2. The New Agricultural Basic Act and the Three Agricultural and Environmental Laws**

Thinking about the recent environmental problems concerning agriculture in Japan, two reasons that the former Agricultural Basic Act (1961) could not deal with the problems well can be pointed out. The first point is the problem of pollution. The Agricultural Basic Act intended to correct "the differences of the productivity with the other industries," and, furthermore, the income gap (Article 1). In order to achieve the goal, single cropping, chemical agricultural methods, and use of large-sized machines were promoted. However, single cropping caused problems

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<sup>10</sup> "With regard to livestock agriculture, the regulation of emission concentration of the substances is expected to make sufficient effects. Thus, farm locations shall be taken into account for the area division. For example, excluding farms from the odor index regulation area (Notification No 286 by the Chief of Air Quality Bureau, Environment Agency, 1995)" (Utamaru, 1998).

such as soil impoverishment and replant failure, which enhanced the dependence on chemical agricultural methods. The chemical agricultural methods, however, caused the problems of chemical residue and ground water pollution. Furthermore the use of large-sized agricultural machines reduced the productivity by compressing the soil (Kajii, 2003).

Second, the law did not guarantee the exercise of the multiple functions of agriculture. The primary concern of the Agricultural Basic Act is the existence of the market and it is described with relations to agricultural workers. Today, however, the number of agricultural workers is decreasing. On the other hand the multiple functions of agriculture are now widely acknowledged by citizens, and awareness and needs for the functions other than productive functions have been rising. The former Agricultural Basic Act could not cope with such realities.

In such circumstance, the Food, Agriculture and Rural Areas Basic Act (New Agricultural Basic Act) was established in 1999. The law specifies the relation with the citizens in Article 1 as it "intends stable improvement of the citizens' life and sound development of national economics." Article 3 describes "practice of the multiple functions," which is defined as one of the basic policies together with "securing supply of safe food (Article 2)," "sustainable development of agriculture (Article 4)," and "promotion of rural villages (Article 5)."<sup>11</sup>

Also, Article 32 prescribes that "the national government shall take necessary measures such as securing appropriate use of agricultural chemicals and fertilizers and improving soil capacity utilizing livestock excreta in order to maintain and promote the natural recycling function of agriculture." Based on this, the Law on Promoting Proper Control and Use of Livestock Excreta (Livestock Excreta Act, 1999) and the Law on Promoting the Introduction of Sustainable Agricultural Production Practices (Sustainable Agriculture Act, 1999) were established. Together

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<sup>11</sup> Although Chapter 2 states "the policy for the securing of stable food supply (Section 2)," "the policy for sustainable development of agriculture (Section 3)," and "the policy for promoting rural villages (Section 4)" as the fundamental policies, there is no mention of a fundamental policy that deals with "the practice of multiple functions". Sakuyama (2006) reasons that "it is regarded as obviously a very natural course that maintenance of domestic agriculture itself will result in the practice of multiple functions, so an independent policy focused on the practice of multiple functions does not exist." However, in Article 35, which mentions "the promotion of the hilled rural area", there is a description, "a policy shall be formulated in order to secure multiple functions in particular" (Clause 2).



with the Law for Revising a Part of the Fertilizer Control Act (Revised Fertilizer Control Act, 1950) in 1999, these laws are called the Three Agricultural and Environmental Laws.

## **5. Improvement Methods**

When we think about livestock environmental problems, in particular, improving the problem of excreta, it is convenient to decide the standards first. First of all, therefore, I propose a concept of environmental capacity. The environmental capacity is a polysemous term and here it means the limit of natural purification. For example, farmland to which excreta is applied, or grassland that livestock animals use, is supposed to be able to purify up to a certain quantity of excreta per unit area without deteriorating the conditions of it. That upper limit I call the environmental capacity. If more nitrogen than the environmental capacity is discharged because of the recent excessive use of chemicals and increase in the number of bred animals, it will emerge as a livestock environmental problem unless any measures are carried out to control it.

Taking this into consideration, the following choices are possible to keep the environmental capacity.

- (1) Excreta cannot be discharged beyond the environmental capacity. Decrease the quantity of excreta to keep the capacity.
- (2) More excreta than the environmental capacity can be discharged. In that case, however, the excreta must be treated.

With regard to (1), because the quantity of excreta produced at a farm is the total of the excreta from each animal kept there, the measures are naturally suggested: (a) decrease the number of animals, or; (b) decrease the quantity of excreta per animal (per weight). However, as (b) is not supposed to be easy to carry out, (a) is the realistic measure. In order to reduce the number of animals and maintain the business at the same time, the value per animal needs to be enhanced. With regard to (2), the measure is to implement an actual excreta disposal method. As (2) is supposed to be more practical from both business and legal points of views, I will briefly talk about it.

The livestock excreta in the form of slurry is called manure, which is a term sometimes used for the meaning of organic fertilizer, too. Originally, livestock excreta is a biomass resource containing ingredients such as carbon, nitrogen and

phosphorus, and has been used as an organic fertilizer.<sup>12</sup> Under the conditions of expanding scale of barns and numbers of animals, and aging producers, utilization of the excreta has been getting more and more difficult. Furthermore, processor-like livestock farming, which does not expand farmland, or even shrink it, has been developed. As a result, livestock excreta has been left piled up in the field or stored in a hole dug in the field, and has become a serious livestock caused environmental problem. Therefore, it is thought to be more effective to consider the excreta as an unused resource than to discharge it after purification treatment. Purification treatment of excreta is also said to be difficult because of the quantity (Higaki, 1980).

Excreta can be used for fertilizer, fuel and feed.<sup>13</sup> For agricultural use (fertilizer), it can be dried, composted, or liquid-composted. To use as energy (fuel), it can be methane-fermented, directly combusted, or made into solid fuel. Furthermore biomass production of feed is possible; the excreta is treated to be used as feed again (Moriya & Kitagawa, p. 234, Matsumoto & Matsuyama, 1995, pp. 253-257). As the expansion of the scale of livestock farming without the expansion of farmland is one reason for the livestock excreta problem, the importance of the cooperation between crop and livestock farmers has been strongly advocated so that crop farmers can use the excreta discharged from livestock farms.

Finally, in addition to (1) decreasing the excreta and (2) treating excreta, I would like to suggest a choice of reducing the amount of livestock products we consume, and I guess it may be necessary. The present livestock industry in Japan greatly depends on imported feed. As mentioned before, this can result in the increase of nitrogen in Japan. It can be said that the aforementioned decreasing or treating of excreta is not a fundamental solution.<sup>14</sup>

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<sup>12</sup> For example, Arai (2000) points out that, in the early Showa era "most livestock animals were mainly for collecting excreta."

<sup>13</sup> Among them, composting is explained in detail in Ito (2005).

<sup>14</sup> Accompanying this subject, I would like to introduce the following arguments. The first argument is, "by reducing just 10% of the meat consumption, the cereals humans can consume will increase by 12 million tons. These increased cereals can feed, if not all, most of those who die of hunger every year, namely, 60 million people" (Bekoff, 2005, p. 139). However, there is also the argument that, under the market economy, the cereals for 10% meat reduction will not be evenly distributed to the 60 million people (Ekaitso, 2008).

## 6. Conclusion

Finally I would like to discuss the livestock environmental problem from a different point of view, namely, in terms of the maturing of society. As we have been seeking economic growth, our diet has been diversified and upgraded. A variety of foods including livestock products are served daily. These food items are brought from every place inside and outside the nation. Globalized and diversified food items are one of the fruits of economic growth.

On the other hand, movements such as local production for local consumption and the slow food movement are being developed and attracting attention. In the background is a value that is different from the value offered by low prices, it may be pointed out that our society is shifting from the stage of "growth," the quantitative improvement of life, to "maturation," the qualitative improvement of life. Furthermore, livestock environmental problems emerged under the growth stage, but under the maturation stage these problems will lead us to their solution.

Specifically, as it has been frequently pointed out, if the local production for local consumption movement results in production of the items that suits the area, it will reduce the problem of food mileage and virtual water. In addition, the inflow of nutrients such as nitrogen contained in livestock products, feed and vegetables that come from outside the area or country will be reduced. The shift from social growth to social maturation may innately accompany the reduction of livestock environmental problems.

If so, the shift from the growth stage to the maturation stage should be emphasized more. In other words, in order to move to a mature society, the whole society needs to make efforts to reduce livestock environmental problems besides the self-help efforts of producers. If value is expressed only in low prices, it is probably difficult economically for producers to begin efforts to solve livestock environmental problems. Unless consumers prefer goods that bring qualitative improvement of life, those goods will not come to the market. The society changes over time and the direction of the change depends on us to quite a little extent. In this sense, clarifying and sharing the vision of the mature society will be a key to solving livestock environmental problems.

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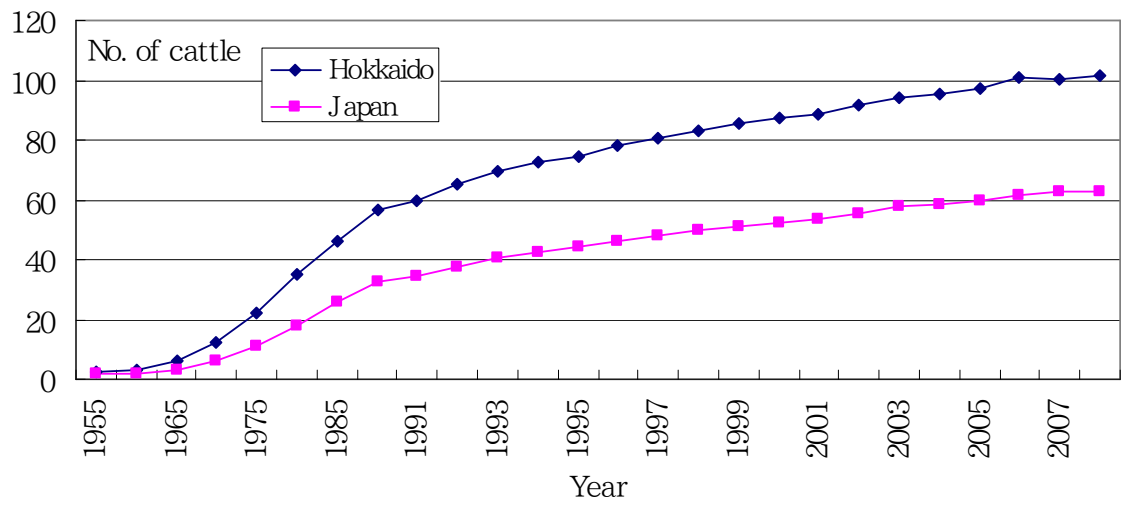


Figure 1. Changes in the Number of Dairy Cattle per Farm

Source: Hokkaido Agricultural Administration Department (2009)

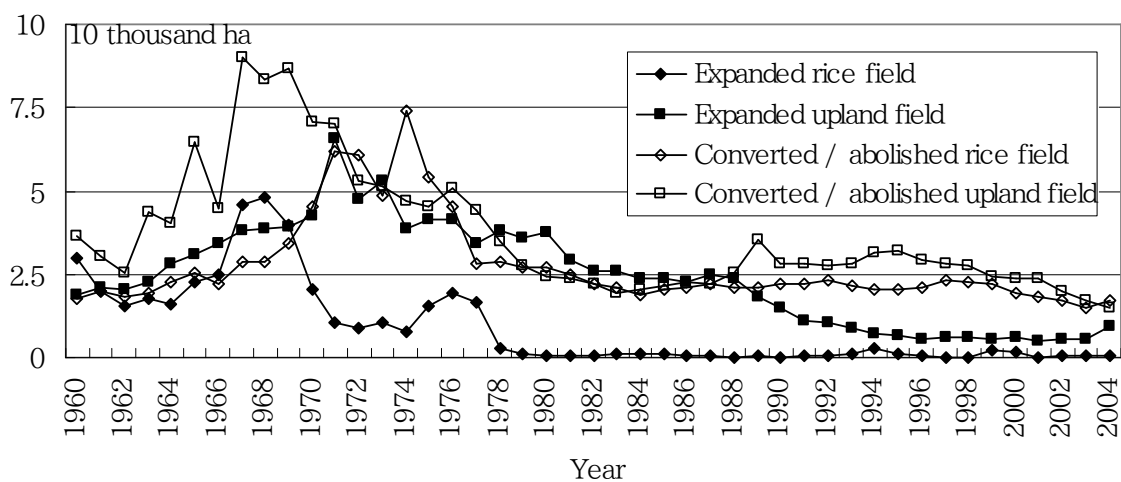
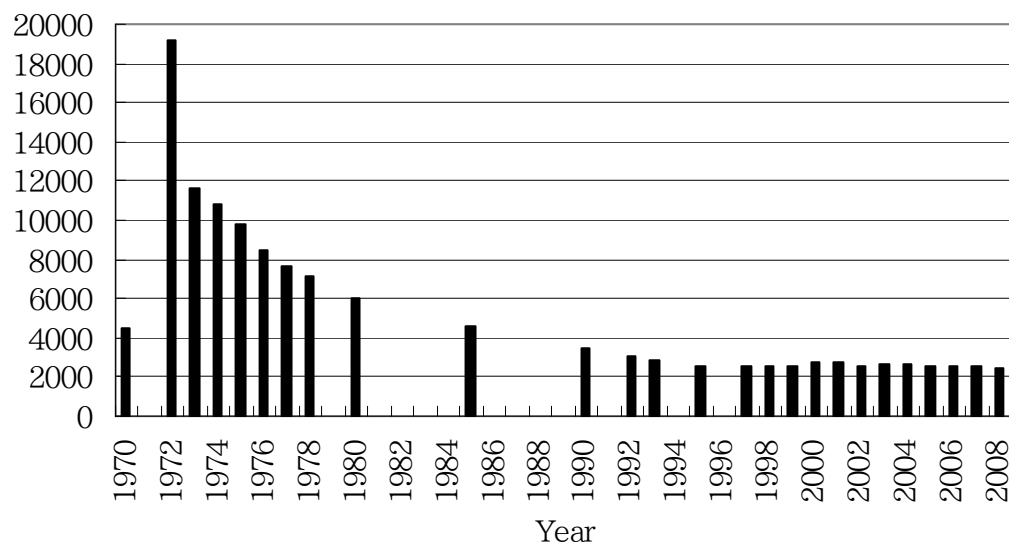


Figure 2. Changes in Expanded and Converted/abolished Areas of Farmland  
 Source: Statistics Bureau, Ministry of Internal Affairs and Communications (2009)  
 7-7 Expanded and Converted/abolished Areas of Farmland (from 1918 to 2004)





*Figure 3. Changes in the Number of Farms That Received Complaints (1970-2008)*

Source: Agricultural Production Bureau, Ministry of Agriculture, Forestry and Fisheries (2008), Higaki (1980), Matsumoto & Matsuyama (1995)

*Note 1.* The total number of complaints about water pollution, offensive odor and others, of pigs, chickens, dairy and beef cattle, and other animals.

*Note 2.* Okinawa is not included in the survey in 1972 and before.

Table 1 Load of Nitrogen in Livestock Excreta and Candidates for Explanatory Variables

Variable	Average	Unit	Year	Source
Load of nitrogen in livestock excreta	2.60	–	–	Moriya & Kitagawa (2007)
Income per resident	27.52	¥100 thousand	2005	Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications (2010a)
Percentage of cultivated area	12.17	%	2007	
Total area of a municipality	80.39	100km <sup>2</sup>	2007	
Land productivity	22.49	¥100 thousand/ha	2006	Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications (2010b)
Percentage of primary industry labor force	7.07	%	2005	
Number of dairy cattle	32.67	thousand	2008	
Number of beef cattle	61.50	thousand	2008	Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications (2010b)
Number of pigs	20.70	10 thousand	2008	
Number of chickens for eggs	38.65	10 thousand	2008	
Number of broilers	21.74	10 thousand	2008	

*Note.* With regard to the load of nitrogen in livestock excreta, the load under 100 kg N/ha in Moriya & Kitagawa (2007) is assumed as the value 1, and values are given to every 50 kg N/ha range. Those higher than 300 kg N/ha are assumed as the value 6.

Table 2 Model Estimate Results of the Load on Farmland of the Nitrogen in Livestock Excreta

	Model 1		Model 2	
Constant term	3.522 (1.530)		3.087 (3.195)	***
Income per resident	-0.028 (-0.428)			
Percentage of cultivated area	-0.068 (-1.523)		-0.085 (-2.258)	**
Total area of a municipality	-0.020 (-2.541)	**	-0.022 (-3.256)	***
Land productivity	0.054 (1.901)	*	0.042 (1.741)	*
Percentage of primary industry labor force	-0.035 (-0.411)			
Number of dairy cattle	0.016 (2.008)	*	0.019 (2.968)	***
Number of beef cattle	0.004 (0.734)			
Number of pigs	-0.015 (-0.933)			
Number of chickens for eggs	0.019 (2.292)	**	0.016 (3.007)	***
Number of broilers	0.017 (2.352)	**	0.017 (4.204)	***
Adj. R <sup>2</sup>	0.581		0.616	
F-value	<0.001	***	<0.001	***
AIC	2.956		2.796	

Note 1. \*\*\*, \*\*, \* are significant at 1%, 5% and 10% respectively.

Note 2. t values are given in parentheses.