Composting of Organic Wastes and Its Utilization Systems in Tokyo Metropolitan Area

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Midori SASAKI

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ABSTRACT

The purpose of this study is to elucidate the basis of organic waste utilization systems through the analysis of the mutual relationship between waste generators and consumers, and locations in Tokyo Metropolitan Area. The case studies were selected; these included a waste generator—Corporation A, which was a soft drink manufacturer, consumers of organic waste—the Recycling Union of Miura Peninsula, and a waste contractor—Corporation E.

First, the characteristics of the business management of each actor were considered. The decision-making behavior that considered organic waste management in Corporation A arose from the social background, laws, and market competitions as external pressures. Despite the high costs involved, Corporation A adopted recycling as the method of waste management after the acquisition of environmental certification and enforcement of the WPDC Law. Next, in Corporation E, the control of supply and demand is an obstacle to the management of business because of a seasonal demand for the products. It is controlled by cooperation with the consumers, i.e., the farmers and the compost-producing corporations. Moreover, the network forms contracts with the carrying origins and supply destinations of commodities in Corporation E. The principle feature with respect to consumers is the seasonal compost use, which occurs because the rate of fertilizer application changes with crop type and soil condition. Further, there are differences in the types and amounts of the products ordered and the process of the second fermentation by the size of farm management.

Second, the interrelation between actors in business relations was examined. As a result, the organic waste utilization systems consist of two mechanisms of two actors' direct business relationship. This relationship between the two actors reflects their position in business management. Hence,

for the existence of organic waste utilization systems, a dealing that supplements the disadvantage of each actor is preferred. For instance, the waste contractor serves these two customers in exchange for the price, and is responsible for forming a relationship between the waste generators and the consumers. It is an important point that the affiliated network between waste contractors forms the waste distribution system. Further, the problem faced by the management in terms of maintaining the balance between supply and demand is solved by double adjustment with the cooperation of waste contractors and farmers. In addition, it is found that the feedback of user's requests for products and the services of waste contractor influence the business continuously.

Third, spatial structure of organic waste utilization is examined. The soft drink manufacturer is agglomerated to certain industrial estates along the highway and the main road toward the central city of Tokyo. Waste contractors are located close to the highway, which is a good access point to the location of other businesses because of high shipping ability. Additionally, sustainable agriculture that uses organisms is conducted remarkably in farming in urban suburb. The main reason they produce vegetables is that there is locational advantage in using organic waste.

In sum, characteristics of a large city including the agglomeration of the industry and the sustainable agriculture that use organisms are identified in Tokyo Metropolitan Area. Organic waste utilization systems have formed in Tokyo Metropolitan Area as a result of each actor's characteristics, business interests and relationships, location, and large area of shipping functions that organic waste contractors covered.

Keywords: organic waste utilization systems, composting, waste generator, food manufacturing industry, waste collection and conveyance contractor, waste-recycling contractor, Tokyo Metropolitan Area

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CHAPTER 1
INTRODUCTION

1. Research Objective and Previous Studies

During the Tokugawa Shogunate Period from the 17th to 19th century, Edo, a capital city of Japan, and its peripheral villages once formed a closed material circulation in which waste from the city such as night soils were exchanged for agricultural product from the villages, to the villages in return for agricultural products. However, under the postwar society of mass production and mass consumption, the amount of waste generation has become enormous and the circulation system in Edo has collapsed (Tsuchida 1989). Today, the waste problem leads to more serious issues.

Waste has been conventionally incinerated or disposed of in the mountainous villages. These regions have supported the high level of consumption in urban areas by accepting NIMBY[1)] in exchange for subsidies. This was only a transitory measure to a large amount of discharged wastes. Inhabitants' distrust has risen gradually with the increase of illegal dumping in the mountainous villages, and they have prevented the establishment of NIMBY. As a consequence, the more illegal dumping increases, the more it has led to soil pollution (Groothuis and Miller 1994, Lawrence 1996) .

The economic society based on mass production and mass consumption has formed a one-way flow without recycling (Togawa 2001). Discharged wastes exceed the ability to purify the environment, and are separated from material circulation. Unless the economic and social structure is changed, there are no methods to solve the waste problem that are separated from the circulation (Tsuchida 1989).

Mita (1996) states that a system of mass production/ mass consumption that is said normally "is a form of infinite fantasy." Instead, the fact is a limited system of bulk collection/mass production/mass consumption/mass disposal." In other words, the economies of human society are limited by natural resources and environment. Therefore, it is clear that it is necessary for any economic systems to deal with the matters related to waste discharge. It is necessary to reduce environmental stress overall through premeditated use of resources, such as minimization of waste discharge and its reuse as a resource as much as possible. The flow of recycling should be made strong in accordance with the flow of production, distribution, and consumption (Togawa 2001). This way of thinking becomes strategy to create a sustainable economic society.

According to the Ministry of the Environment, as of 2000, the total amount of waste in Japan is 458.36 million tons[2)]. The amount of waste has not changed much over the past decade. It is still a critical situation, however, because the remaining years available for the final disposal site are 1.2 years in metropolitan areas and 3.9 years, on average, for the national (Ministry of the Environment 2003). Inevitably, various laws were enforced from 1999 to 2000 to restrain the waste disposal and to recycle waste for a sustainable society[3]. However, the rise of the waste-recycling rate has risen very little. It is pointed out that, if environmental and economic benefits do not coexist, the possibility that recycling permeates into a society will remain low (Nosei journalist no kai 2000).

Among all waste, organic waste[4] is an especially valuable resource in terms of both quantity and quality for the following three reasons. First, it occupies 57%[5] of the total amount of waste in Japan (Seibutukei haikibutsu risaikuru kenkyukai 1999). Second, it can be resolved directly to the environment by the biological resolution. Third, the use of organic waste as a new energy is anticipated in the future. Because of such characteristics, agriculture is expected to contribute significantly to the utilization of organic waste. Birch et al. (1976) suggest the necessity of recycling based on the waste composition because, although it is a major factor for environmental pollution problems, organic waste has high utility for feeds and fertilizers. Compost and use of barnyard manure on farmland has been conducted systematically since the transition period from shifting cultivation to sedentary agriculture (Mather and Hart 1956). In their recent research, Shinohara (1992) and Sasaki (2003) investigate the limited aspect of sustainable agriculture production, that is, fertility maintenance. They indicate that supply and demand of composts is effectively used in the scale of settlement, village, or neighboring town village, and they contributed to agricultural maintenance of the area. In addition, treatment of composts and their usage are different depending on the culture and physical characteristics of the region (Hobson and Robertson 1977).

The above research focused on the consumers of organic waste. On the other hand, Jenner (1998) suggested the importance of constructing a distribution system that includes the present condition and correspondence of waste generators. Furuta (1996) demonstrated the regional structure of fish manure distribution viewed from the distribution system, which integrates production area, distribution base, and consumption area. Kim (2001) found technological development and expansion of marketing channels of manufacturing of value-added products as key subjects of animal excreta's distribution in the U.S. market. Nagashima (1998) found that the balance of compost's supply and demand in Tokyo Metropolitan Area fluctuates, and the consumer of organic waste is limited. For the construction of a sustainable society, an ideal form is that discharged waste is managed in a minimum spatial scale so that it does not burden environmental stress in other areas. However, the location of the industry that supports Japanese economy accumulates in a specific region. Accordingly, actual material circulation is more complicated because those that discharge organic waste and those that consume organic waste are unevenly distributed (Togawa 1993) and their needs are different. Therefore, the study needs to have aspects on both waste discharge and its consumption.

Although the utility of organic waste is high, problems of discharge have become aggravated in agriculture in such cases as improper management of animal excreta in large-scale livestock farming. Thus, the adverse effect on the life environment, like underground discharge of toxic substances, is prevented by the "Law on Promoting Proper Management and Use of Livestock Excreta" (LPPMULE). In addition, the changeover to agriculture that reduces environmental stress through appropriate use of organic waste is being practiced in agriculture by the "Law for Promoting the Introduction of Sustainable Agricultural Production Practices" (LPISAPP). Proper management of organic waste brings about long-term agricultural production and stable farm management. Grasping the actual condition of organic waste use is highly valuable not only for the reduction of environmental stress but also for construction of a sustainable agricultural system. Although there are many governmental guidelines for sustainable society, it must be said that the effect is still low. For example, while there are about 2,500 compost centers in Japan that are funded by government, less than 10% have surplus management (Ogawa 1999, Yoshida 2001). Moreover, their utilization rates are low, and there are a lot of cases that stop working. Companies and facilities that handle food wastes have a passive attitude toward introducing recycling (Nosei journalist no kai 2000). It can be said that such results show that, although necessity of recycling is being recognized, its achievement is still in a stage of seeking.

Research on waste in various fields such as environmental science and social engineering has focused on the treatment technology and policy. These studies, however, have not examined the spatiality of waste, namely, its location and regional characteristics (Ishii 2000, Kurishima 2002). Some researches have referred to waste location, for example, research on the recycling system of waste paper and scrap iron (Togawa 1994), on waste in the automobile industry (Togawa 1998), and on waste recycling in the food industry (Akimoto 1994). Togawa (1993) considers the meaning of studying waste from a spatial aspect. He points out the indispensability of elucidation to the industrial allocation and regional structure because agitation of metabolic changes between human and nature occurs in different spatial units. Ishii (2000) also emphasizes the aspect of environmental problems in the region. He states the analysis of the waste-related industries' allocation system and regional circulation of waste is key to the construction of a sustainable society. Waste reflects society and culture in the region significantly (Hawkins and Muecke 2003). Consequently, to consume waste continually, it is important to find essential factors not only in terms of spatial aspects of those who discharge waste and those who consume it, but also their relationship, including the socioeconomic structure that surround them.

2. Purpose of Study and Methodology

The food system theory is an effective approach to concern the above research subject. The food system theory is a study of an integrated system between actors from agriculture, processing, and distribution related to food production and consumption. The food system theory was originally founded in Western food economics. It was advocated because of necessity for studying the flow of food and foodstuff with the separation of eating food and farming in Japan (Takahashi 2002). Likewise, the food system theory has been discussed as a possible approach in agricultural geography (Bowler and Ilbery 1987, Atkins 1988, Araki 1995). Recent closer relations between agriculture and other industry have changed the situation of agricultural production, and the food system theory was developed as necessary tool to confirm these conditions. The following points have been given little attention in agricultural geography: (1) dynamics and circulation aspects; (2) synthetic grasp between each sector (Tabayashi and Fujinaga 2000). By adopting the food system approach, many issues can be addressed (Araki 1995). Food system theory enables the researcher to analyze research objects systematically and to clarify the function of system components dramatically. Accordingly, it can comprehend cause and effect in the system as a complex interaction network. Moreover, the food system theory can discuss the relationship among the research system components from the microscopic level to the macroscopic level within the system (Huggett 1999).

Food system theory takes recycling into account and seeks its systematization from the empirical research of food loss in recent years (Tsunashima 1999, 2001a, 2001b). The research in food system has been established for '*arterial industry*'[6)] in production. '*Venous industry*' or waste consumption, in contrast, has yet to be systematized in food system theory. Analysis of the food recycling system is, however, recognized as one methodological approach to solving environmental problems.

Therefore, this study integrates the recycling concepts related to a sustainable society and food system theory in order to analyze the relationship of various elements of organic waste distribution and consumption

The purpose of this study is to elucidate the basis of organic waste utilization systems through the analysis of the mutual relationship between waste generators and consumers in Tokyo Metropolitan Area. Figure 1 shows the framework of this study. Basis actors in organic wastes utilization systems are waste generators and consumers of organic waste. The term 'actor' is defined as a person or organization that plays certain roles in the interaction within the system. This study considers several questions on actors and systems: What socioeconomic factors that occur inside and outside of systems have influenced these actors? What kind of condition did they form? How did actors maintain the relations by dealing with other actors? In what ways were

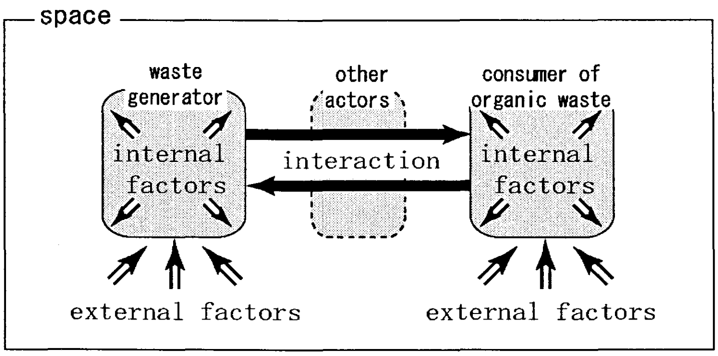


Figure 1 Systems of organic waste utilization

they able to manage and maintain the relations? Furthermore, this study clarifies the spatial structure of organic waste's utilization system from the location of the actors.

3. Research Procedures

This study analyzes in the following processes:

First, Chapter 2 defines an organic waste. The amount of discharge by each industry and the amount of waste generation by all prefectures are explained in *Industrial Waste Discharge and Treatment Conditions Investigation Report* published by the Ministry of the Environment. There is no national data on organic waste recycling. Hence, data on sustainable agriculture from *2000 World Census of Agriculture and Forestry* is applied to infer the condition of organic waste utilization. The main reason for this procedure is that organic waste has been traditionally used as a substitution for chemical fertilizer in sustainable agriculture. Thus, regional characteristics of organic waste utilization are accounted by sustainable agriculture as an index of recycling. Then, a prefecture that has a large amount of waste generation and a large number of farmers who adopt sustainable agriculture is selected. Furthermore, farmers who continuously use compost made from organic waste are chosen within a prefecture.

Second, cases of waste generators, recycling treatment, and consumers of organic waste are analyzed in Chapters 3 to 5. Chapter 3 examines the structure of waste discharge and waste management in a case study of a company that discharges organic wastes. In Chapter 4, the recycling treatment mechanism and the distribution structure of organic waste are investigated in the case of an industrial waste-recycling contractor. Chapter 5 concerns farmers, who reproduce resources, and analyzes the actual condition of organic waste utilization and the conditions of compost selection. Data on organic waste is difficult to obtain mainly because the data is related to private interests of companies, and disclosure of existing information is extremely limited. Therefore, the data were collected by interviewing a company, a contractor, and a farmers' organization.[7] Valuable data were offered by the company and the contractor on analyzing discharge, treatment, and distribution of organic waste. In addition, in order to analyze the correlation between compost use and traits of farm management, data were collected by interviewing six farmers who represent farmers' organization.

Third, the features of waste generators, recycling treatment, and consumers of organic waste are examined and are synthesized in Chapter 6. Subsequently, interrelation among actors' interests in the dealings and their location are considered to lead the basis of the organic wastes utilization system. Finally, the findings in this research are compared with previous literatures, and the generalization of the organic waste utilization system is derived.

CHAPTER 2

CHARACTERISTICS OF ORGANIC WASTE GENERATION AND COMPOST UTILIZATION IN JAPAN

1. Regional Characteristics of Organic Waste Generation

In this chapter, the regional characteristics of organic waste generation and its utilization as compost in Japan have been clarified. The features of industries that discharge organic waste and the regional difference are examined in this section.

In 1999, the total waste discharged in Japan rose to 486.25 million tons (Figure 2). Waste is divided into industrial waste, which consists of industrial refuse, and domestic waste, which consists of industrial refuse and household solid waste. Industrial waste accounts for 82.2% of the gross weight of the total waste. Sludge forms the highest fraction of the waste discharged (46.8%), followed by animal excreta and debris. These wastes with large weights account for 80% of the industrial waste. On the other hand, domestic waste forms 17.8% of the gross weight of the waste. Household solid waste accounts for 66.0% of domestic waste, and the remainder is generated as industry refuse. Domestic waste is roughly divided into garbage and human waste, with the garbage accounting for 62.4%. The generation of industrial waste and domestic waste tended to increase until 1990. Thereafter, it has remained almost constant.

The ratio of organic waste in the waste gross weight has risen to 77%[8).

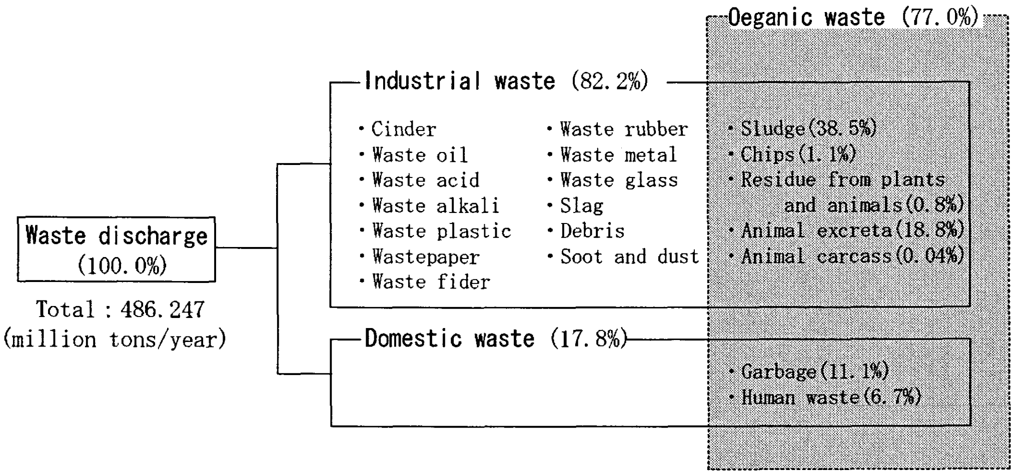


Figure 2 Classification of waste and quantities, 1999

Note: 'Sludge' includes metallic sludge and 'garbage' includes rubbish or litter because of data restriction.
Gross weight of organic waste estimates more than real pure amount.
Numerical value in [ ] is the ratio in the waste total amount.

(Source: Ministry of the Environment)

The amount of organic waste that comes from industrial waste is 59.2%. Organic wastes that have been included in the data in the Ministry of the Environment are sludge, chip, residue from plants and animals, animal excreta, animal carcass, garbage, and human waste. In particular, sludge and animal excreta with high moisture contents are the most discharged wastes followed by garbage and the human waste component of domestic waste.

Industrial waste that forms a large amount of discharge is generated from the following industries (Table 1): manufacturing (30.0%); agriculture (23.0%); electricity, gas and water (22.6%); construction (19.1%); and mining (4.4%). The five most important manufacturing industries are pulp, paper, and paper products; iron and steel; chemical and allied products; ceramic, stone, and clay products; and food industry. These industries give rise to a large amount of discharge of industrial wastes such as sludge, waste oil, waste acid, waste metal, and animal excreta. These wastes have a high moisture content and high weight.

The amount of organic waste generation by prefecture was summed. Figure 3 indicates the regional characteristics. The amount of organic waste is the highest in the southern part of Kanto region, including Tokyo Metropolis, Chiba, Kanagawa, and Hokkaido Prefectures, followed by Aichi, Osaka, and Hyogo Prefectures. Furthermore, the amount of waste generated is also high in Ibaraki, Saitama, Shizuoka, Ehime, Fukuoka, and Kagoshima Prefectures. It is

Table 1 Amount of industrial waste by industrial types, 1999

Unit : × 1, 000 tons

Industries	Amount of industrial waste(%)
Manufacturing	120, 046 (30. 0)
Agriculture	91, 855 (23. 0)
Electricity/Gas/Water	90, 220 (22. 6)
Construction	76, 236 (19. 1)
Mining	17, 655 (4. 4)
Others	3, 787 (0. 9)
Total	399, 799 (100. 0)

Note: 'Others' includes forestry, fishery, transport/communications, wholesale, retail and service.

(Source: Ministry of the Environment)

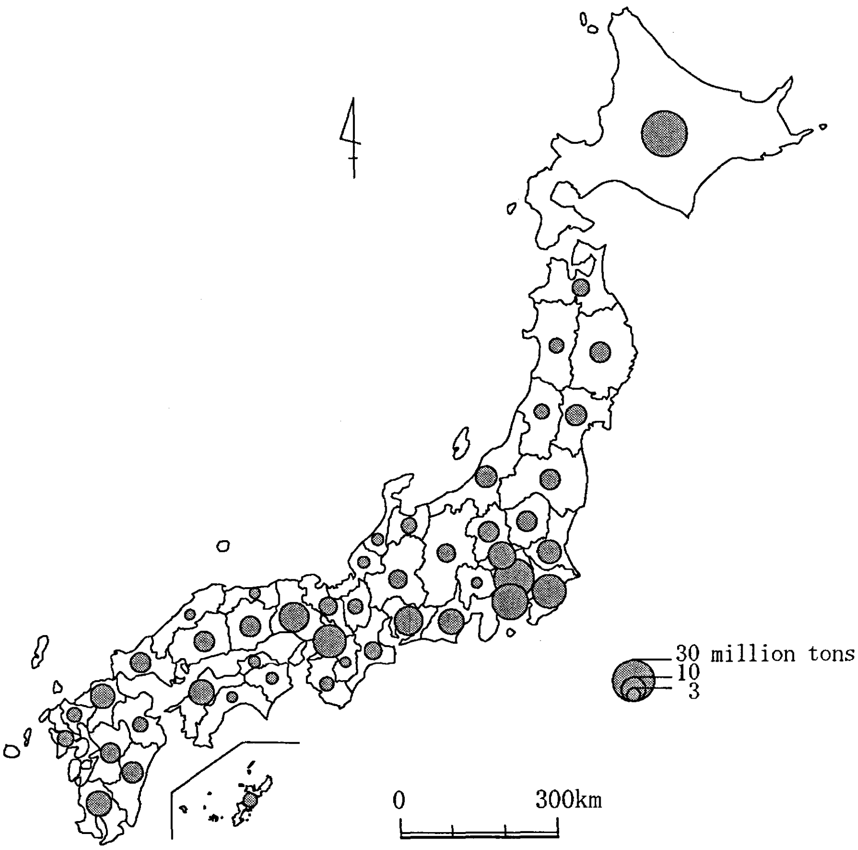


Figure 3 Amount of organic waste by prefecture, 1999

Note: 'Organic waste' [100.0%] includes industrial waste [76.9%] {sludge, chip, residue from plants and animals, animal excreta and animal carcass} and domestic waste [23.1%] {garbage and human waste}.
'Sludge' includes metallic sludge, and 'garbage' includes rubbish or litter because of data restriction.
Gross weight of organic waste estimates more than real pure amount.
(Source: Ministry of the Environment)

considered that the amount of organic waste is high in three major metropolitan areas as a center, i.e., Tokyo, Osaka, and Nagoya, and in Hokkaido Prefecture and Kyusyu District. Sludge, which accounts for 38.5% of organic waste, is discharged from manufacturing industries such as pulps, construction, mining, and food industries. Therefore, it is considered that the amount of waste is high in the city areas in which these industries are concentrated. Similarly, it appears reasonable to assume that the amount of waste generation has been high since the livestock-farming areas in which large amounts of animal excreta are generated are concentrated in Hokkaido and Kagoshima Prefectures. Thus, the generation of organic waste reflects the existence of regional industries.

2. Regional Characteristics of Sustainable Agriculture

Organic waste has greatly contributed to agricultural production by means of composting and foddering. Figure 4 shows the stages of organic waste utilization in agriculture. In the past, each farm management circulated organisms when draft animals were used in farms. The number of domestic animals has decreased with the introduction and spread of agricultural machinery since the beginning of 1950s. In addition, the widespread use of chemical fertilizers has decreased the farmer's dependency on compost. Organism utilization in each farm management disappeared due to these

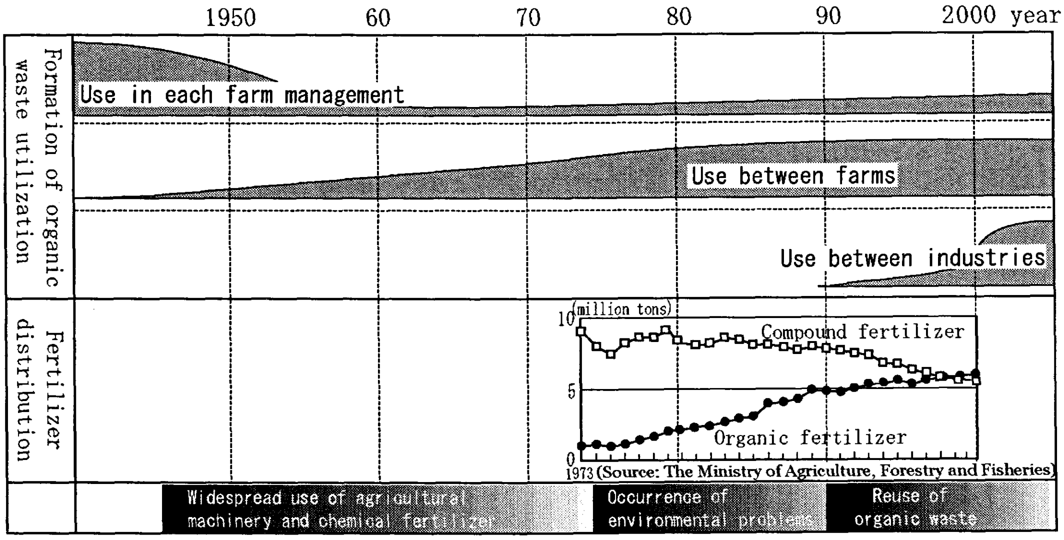


Figure 4 Stages of organic waste utilization in agriculture

reasons. Large-scale farming and an improvement in the efficiency of farm management disturbed compost use, which is a time-consuming process. Further, an excess organism has given the stress to the environment as waste. Farm management became lopsided at a specific section due to the selective enlargement of agriculture. In addition, the agricultural region was changed due to the change in land use by urbanization and abandoning of farming. Under such circumstances, a farmer who anticipated soil exhaustion with chemical fertilizer at an early stage and required a large amount of organic fertilizer agreed to the mutual use of organisms with a livestock farmer (Sasaki 2003). Environmental problems such as replant failure caused by the decrease in fertility and treatment of animal excreta emerged after the 1980s.

The Board on Agriculture, National Research Council (1992) describes "alternative agriculture" as "to take and to use intentionally a useful interaction that exists in the natural world." In other words, it was pointed out that the agricultural system that does not use chemical substances tends to have a stable flexibility with strong and resistance to drought and damage by harmful insects. For instance, Sasaki (2003) investigated cool summer damage of a paddy field and reported that the applied compost was lesser than that required in a paddy field that depended on chemical fertilizer. Moreover, it is clear that the influence of pesticides on the biological components in soil can be controlled by the utilization of organic materials such as compost (Son et al.

1985). Additionally, Sugimoto et al. (1984) reported that, as compared to paddy fields that use chemicals, the number of rice insect pests is low in the paddy fields where natural farming is carried out and their natural enemy—the arachnidan—is abundant. Compost not only acts as a fertilizer but also gives rise to crops that can withstand severe natural environment and damage caused by harmful insects by an active microorganism's effects. Therefore, composts have several advantages that cannot be provided by chemical fertilizers. As a result, compost use was revised and actively used for soil making in various places. Therefore, alternative agriculture was shifted to sustainable agriculture in the policy. Sustainable agriculture is defined as the circulation of materials and reduction in environmental stress through the making compost with concerning the productivity. In fact, marketing of the organic fertilizers has been augmented ever since environmental problems became remarkable (Figure 4).

Further, the laws concerning recycling were enacted in order to form a sustainable society in the beginning of 2000. In order to the laws, the food industry discharged organic waste entered fertilizer industry. The waste discharged by the food industry has been recycled for crop farmers in a specific area or contract farmers. Organic fertilizers were marketed to an extent than compound fertilizers in 1998[9]. Organic material has been gradually used in industries. According to the Japan Organics Recycling Association (2004), approximately 80% of animal excreta with high amount of generation, 60%[10] of the sewage sludge, 30% of the inedible part of rice straws and rice hulls, and approximately 10% of food waste are recycled in an agricultural section. In the next section, the regional characteristics of organic waste utilization are examined from the viewpoint of the actual conditions of sustainable agriculture that has an extremely high potential of utilizing organic waste.

Sustainable agriculture includes agriculture in which the utilization of pesticides is reduced. In this study, the ratio of farms that practice soil making using compost instead of chemical fertilizers has been investigated by prefecture (Figure 5). A high ratio was observed in a decreasing order in Nagasaki, Tokyo, Miyazaki, Kagoshima, Kanagawa, Yamanashi, Nagano, Hokkaido, and Gunma Prefectures. Oita, Aomori, Iwate, Chiba, Miyagi, Saga, and Kumamoto Prefectures had a value that was greater than the average. Therefore, the ratio of the farms that practice soil making using compost is high in the peripheral parts of metropolitan areas such as the southern part of Kanto District and Koshin Area, Hokkaido Prefecture, and Kyushu District. There is a great demand of safe food, and superior-quality crops are being produced in the peripheral parts of the metropolitan areas. In addition, agriculture that considers the environment[11] expands to urban suburbs for high accessibility to the market (Beauchesne and Bryant 1999). Moreover, the ratio of farms that make soil-using compost is high in Hokkaido and Kyusyu, in

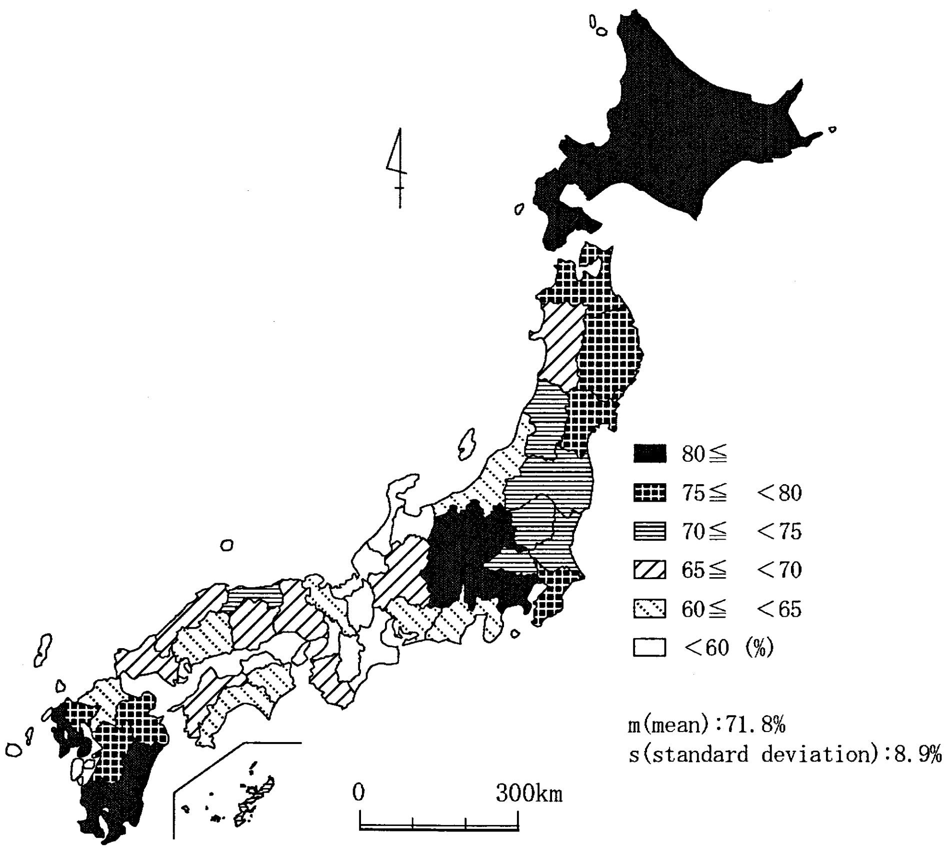


Figure 5 Ratio of compost producing farms by prefecture, 2000

Note: Only commercial farm is an object.

$$[\text{Ratio}] = \frac{[\text{the number of compost producing farms}]}{[\text{the number of farm households that practice sustainable agriculture}]} \times 100$$

(Source: World Census of Agriculture and Forestry in 2000)

which livestock farming area wherein a large amount of animal excreta is discharged.

There is a method for reducing the use of chemical fertilizers and pesticides in sustainable agriculture. The amount of reduction differs depending on the crop type and natural conditions in the region (Figure 6). Thus, there are regional differences in the feature of crops in sustainable agriculture. Rice cropping in sustainable agriculture develops in production areas such as Kinki, Hokuriku, and Tohoku Districts. The ratio of vegetable production in sustainable agriculture is particularly high in Kanto, Shikoku, and Kyusyu Districts. The value for fruit trees is high in fruit tree production areas such as Koshin District. There are other ideal crops for sustainable agriculture such as sugarcane in Okinawa Prefecture, tea in Shizuoka Prefecture, and miscellaneous grains, tubers, and pulse crops in Kyusyu District. Shiga (1994) indicates the necessary amount of animal excreta that is essential in the maintenance of soil fertility; it is the highest in vegetables, followed by the tea trees and paddy.

3. Selection of Case Studies

Regional differences exist in the generation of organic waste and its utilization as compost. In particular, the generation of organic waste is high in the Kanto District. It was considered to be a suitable case study area because a

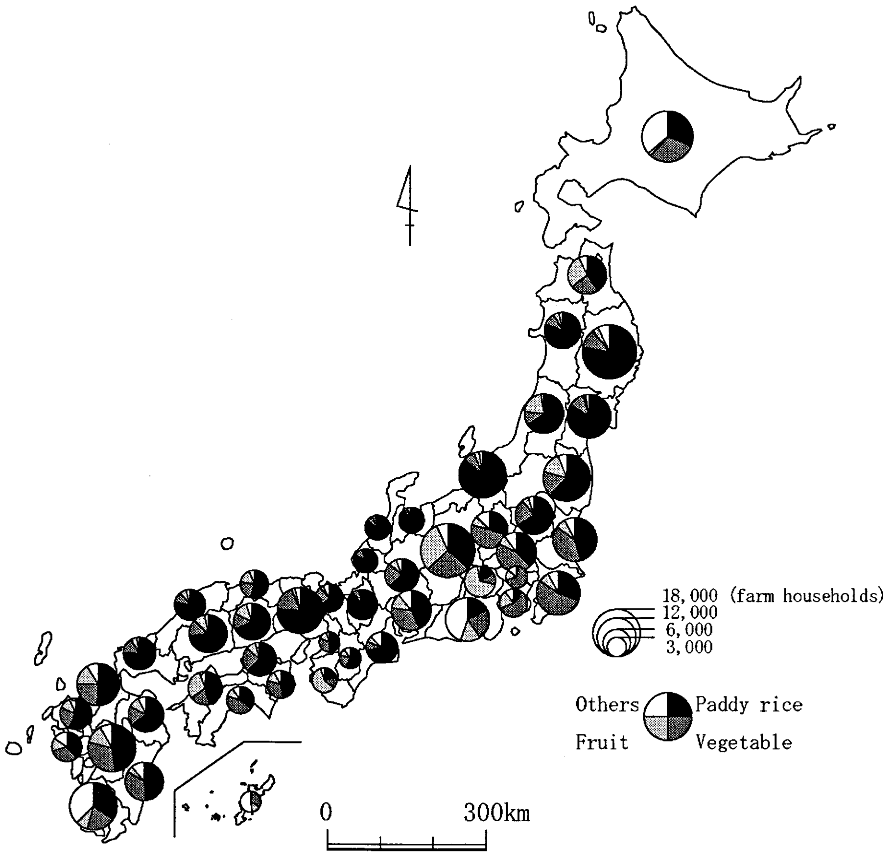


Figure 6 Number of farms that practice sustainable agriculture by prefecture, 2000

Note: Only commercial farm is an object.
Details are shown the number of farms by principal crop types.
(Source: World Census of Agriculture and Forestry in 2000)

number of farmers in this area make soil-using compost. Moreover, one of the focuses of this study is the utilization of organic waste discharged by industries that may expand in the future. In order to select the case study area, the manufacturing industry that discharged the highest amount of organic waste and the ratio of farms that practice sustainable agriculture were examined at the municipality level in Kanto District.

First, the region where the maximum amount of organic waste was discharged from the manufacturing unit was determined. The industries belonging to the mid-level industrial classification in manufacturing, which discharged organic wastes, were selected. These are establishments with more than 30 employees (Figure 7). Many such establishments are located in a range of 50 km range from the Tokyo civic center. The municipalities where several establishments exist expand in the inner city and coastal area in 20–40 km from the Tokyo civic center. Moreover, the municipalities where several establishments exist are noted in the periphery of the seat of prefecture government in the northern part of Kanto that is approximately 100 km from Tokyo. It is clear that establishments expand radially along the expressway from Tokyo to these municipalities. By local policy, industry has diffused to the metropolitan suburbs or the districts since the latter half of the high economic growth period. Regions to which the industries diffused were upland field areas on the diluvial upland where plain woods and mulberry fields were spread out

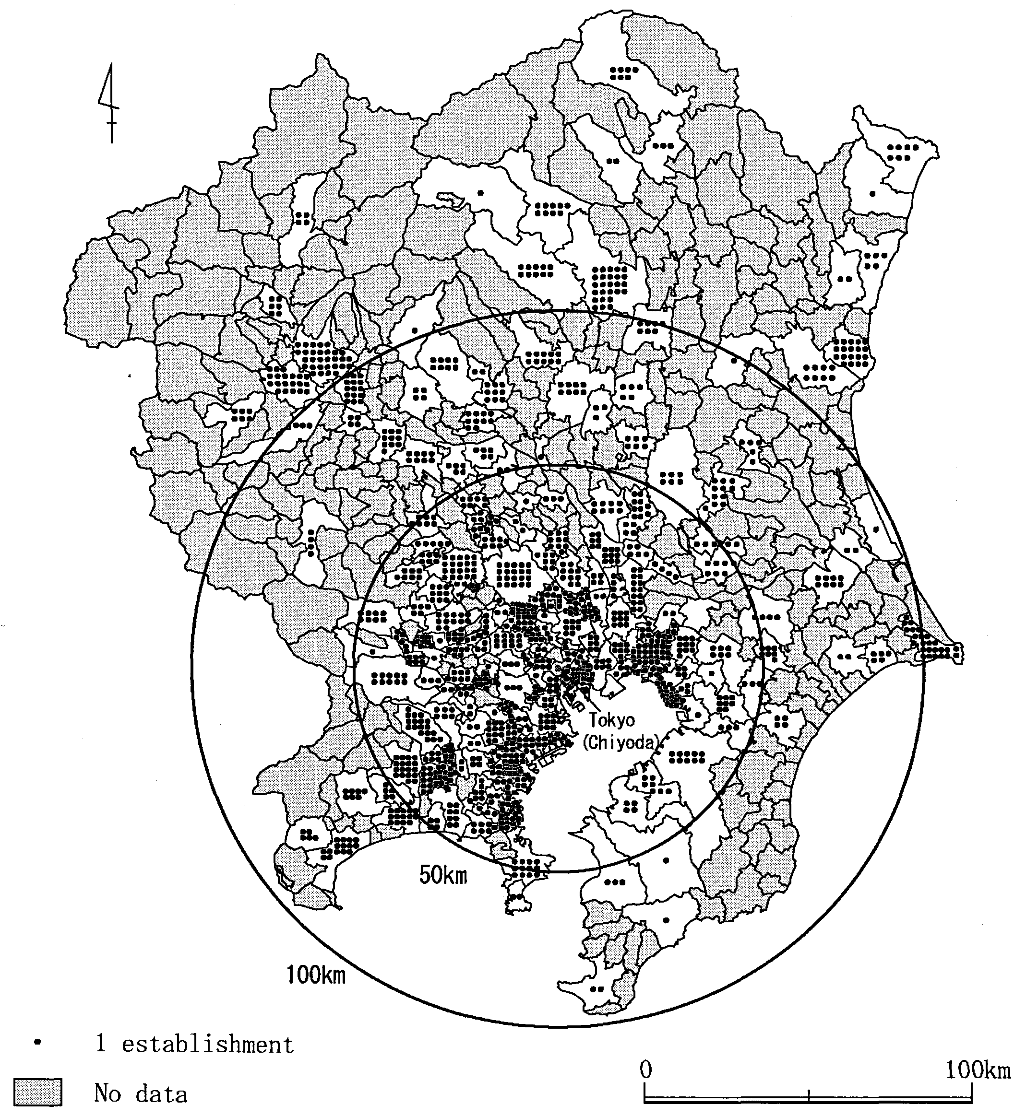


Figure 7 Number of business establishments that discharge organic waste in the Kanto District, 2002

Note: Number of establishments is calculated 'manufacture of food', 'manufacture of beverages, tobacco and feed', and 'manufacture of lumber and wood products, except furniture' under mid-level industrial classification.
Town and village have no data.
Object is establishments with over 30 employees.

(Source: Census of manufactures in 2002)

(Kikuchi 2000). Several small plants exist in Tokyo. In contrast, in Kanagawa, the large industries have agglomerated both shipment value and the scale of an establishment (Akabane 1991). Industries such as food and wood manufacturing, which discharge organic waste, generally have a material orientation. Hence, these industries were often dependent on areas with agriculture, forestry, and fisheries. However, the location has shifted to the consumption areas, where accessibility is high, due to increasing demand and the development of industrial sector in recent years. In addition, the industries tend to be located in ports or in the neighborhood of large cities because the ratio, which depends on foreign countries for the supply of material, is high in these places. Thus, the industries discharging organic waste are agglomerated in the coastal areas or city peripheries near the consumption area. The necessity of waste management has risen in specific regions in which large-scale plants are present.

Second, the regional features of sustainable agriculture using recycled compost in Kanto District were analyzed. It is remarkable that the region with a high ratio of farms practicing sustainable agriculture lies within a 10–60 km range from the Tokyo civic center (Figure 8). The regions with a high ratio of agricultural activities have developed, in the western part of Suginami Ward, the eastern part of Hachioji City in Tokyo, the northeast part of the coastal area in Chiba City, and the southern part of the coastal area in Yokohama City. This

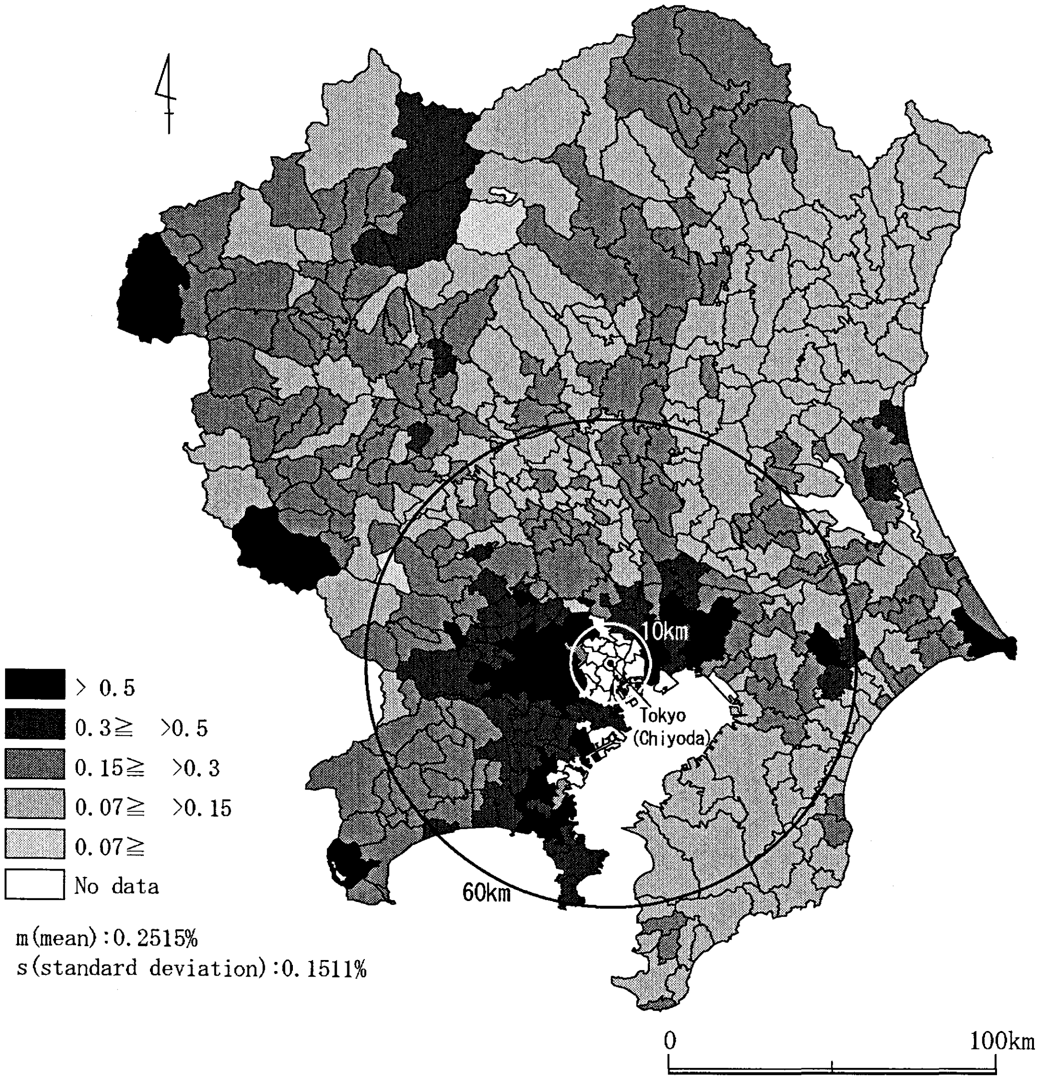


Figure 8 Number of farms practicing sustainable agriculture in the Kanto District, 2000

Note: [Ratio of farm households that practice sustainable agriculture]

$$= \frac{\text{[the number of farm households that practice sustainable agriculture]}}{\text{[the number of farm households]}}$$

(Source: World Census of Agriculture and Forestry in 2000)

can be figured out as a structure of star type as well as the diagram of an agricultural, regional formation in Kanto District that Shirahama (1964) clarified. Sustainable agriculture has developed due to the demand for food of high quality, which is a trait in cities. Hence, the agriculture tends to concentrate in the city suburbs (Ilbery et al. 1998, Klonsky and Tourte 1996). On the other hand, sustainable agriculture also develops in regions designated as vegetable production areas, such as Choshi City, Tsumagoi Town, and Miura Peninsula. As confirmed in the previous section, sustainable agriculture in vegetable farming is particularly practiced in the southern part of Kanto District, and it is distributed in the upland fields of Musashino.

Thus, the generation and use of organic waste were distributed on the diluvial upland. In order to recognize the actual conditions, the regions generating and utilizing large amounts of organic waste should be examined. Therefore, Kanagawa Prefecture was selected as the case study area. In Kanagawa Prefecture, there is an increase in vegetable farming along with the development of large-scale manufacturing plants. In order to achieve the purpose of this research, case that the organism has been continuously used is adapted. Consequently, three actors in this study were selected as follows (Figure 9): (1) farmers' organization in Miura Peninsula that pioneers the practice of organic utilization, (2) a soft drink manufacturer in a prefecture in which organic waste is supplied by the farmers' organization, and (3) an

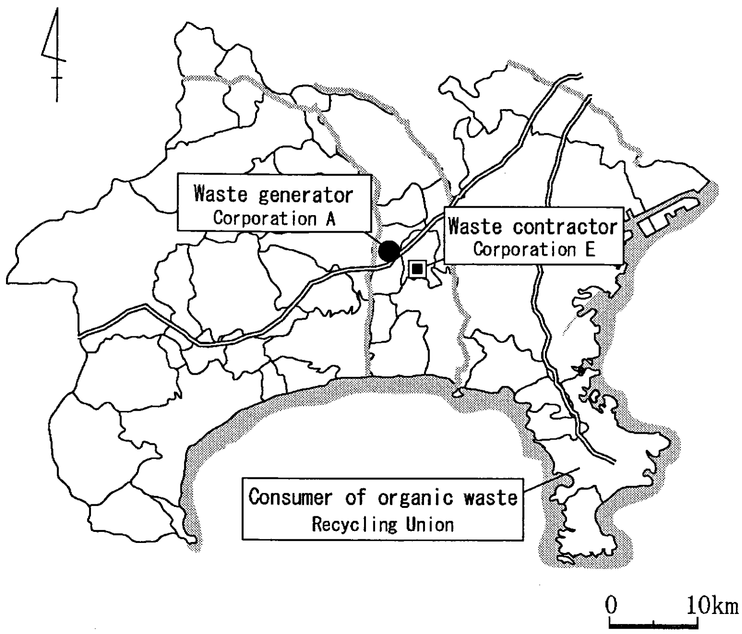


Figure 9 Location of actors in this study

industrial waste contractor involved in the collection, conveyance, and the treatment of organic waste.

It is located in an agricultural circumstance to promote the abandon farming in Miura Peninsula. However, the peninsula has maintained its status as a source of food supply to large cities for many years, and it represents the vegetable production area in Japan. The farmers' organization has used organic waste positively for 15 years from 1989 to the present in Miura Peninsula because it is located in the region in which the amount of organic waste is high. The farmers' organization has chiefly used the organic waste discharged by four soft drink manufacturers, i.e., corporations A, B, C, and D. Further, the corporations are located in the periphery of the consumption area along the expressway, and the sales and production scale are large. Corporation C provides the maximum amount of organic waste to the farmers' organization in Miura Peninsula. However, Corporation A was selected as the case study of a waste generation because it provided cooperation to the investigation. Corporation A not only has the largest scale of production among these four corporations but also ranks first with respect to market share in the entire food manufacturing industry as of 2001. The three actors in the study were the farmers' organization in Miura Peninsula, Corporation A, and Corporation E is a waste contractor involved in the treatment of organic waste from Corporation A and its deliver to the farmers' organization. The system of organic waste utilization in Tokyo Metropolitan Area has been clarified by analyzing these cases.

CHAPTER 3

STRUCTURE OF ORGANIC WASTE MANAGEMENT – A CASE STUDY OF THE FOOD MANUFACTURING INDUSTRY –

1. Business Development and Production of Corporation A

The Japan Soft Drink Association controls the soft drink industry. As of 2004, 87 commissioning manufacturers and processing trader, excluding small and medium-sized entrepreneurs, and 109 related entrepreneurs[12)] have joined the soft drink industry. A milk-based beverage prepared with the help of lactic acid bacteria and the beverages with an alcohol content of 1% or more are not considered to be soft drinks. There has been a gradual increase in the production of the soft drinks in Japan. It exceeded 16 million kiloliters in 2002. The total sale of soft drinks in the fiscal year 2003 was 3.28 trillion yen. However, the management of the entire industry is still severe. Green tea beverages and mineral water have the highest demand. Additionally, the demand for amino acid beverages and bean milk-based drinks has increased due to the health boom in recent years. Moreover, the demand for tea beverages and vegetable beverages has also increased. There has been a shift to the use of PET containers, with the share approaching 60%.

The Basic Law for Establishing the Recycling-based Society was enforced in 2000. In the soft drink industry, it acts on the reduction of carbon dioxide's emissions, and the raise of recycling rates of waste and used containers. Since the law concerning the promotion of the use of recycled resources had been enforced in 1991, the recycling of PET was reinforced in the soft drink industry. The rate of collection of PET reached increased to 50% or more in 2003. The soft drink industry is developing a high standard of PET recycling. However, the Waste Disposal and Public Cleaning Law (WDPC Law) was revised in 2003. Therefore, each corporation in the soft drink industry is expected to take the responsibility toward waste management. Similarly, each corporation in the industry is promoted to acquire an ISO14001 environmental certification[13]. They are working toward environmental preservation through environmental management. Furthermore, the corporations make comprehensive efforts to introduce the Hazard Analysis and Critical Control Point (HACCP) [14] to place the emphasis on safety and hygiene of the product to maintain the appeal to the consumer. It took a general view of the above-mentioned trend of the soft drink industry. The waste management structure of organic waste is analyzed in this chapter. It is a case study of the soft drink manufacturing plant of Corporation A that is located in Kanagawa Prefecture, Ebina City (Figure 9).

Corporation A, which has its headquarters in Tokyo, is a soft drink manufacturing corporation established in 1957. Corporation A began the manufacturing and sales of carbonated drinks for the first time in Japan. At present, it has maximum business in the soft drink industry. Corporation A owns 15 contract corporations based on the license in Japan, and the plant of each corporation[15] manufactures the product (Figure 10). The product is delivered to offices and retail stores by the joint delivery system of the headquarters and the contract corporation. These offices and retail stores become the base of the sales of each contract corporation. The case study—the Ebina plant of Corporation A—was in the jurisdiction[16] of the contract corporation that developed the business in Kanagawa Prefecture and was established in 1971. The selling areas of the corporation, which become the business base of the Ebina plant, are Kanagawa, Shizuoka, and Yamanashi Prefectures. The annual sales of this corporation are about 118.8 billion yen, which is the fourth in Corporation A group. The headquarters of this contract corporation is attached to the Ebina plant, and the lot area at the entire plant including the headquarters building, is approximately as 91,000 ㎡. In addition, the logistics center[17] that is adjacent to the Ebina plant is a kernel of the distribution network in the metropolitan area according to the low cost operation system of automatic 24 h operation.

The Ebina plant has given priority to the product manufacturing section since operations began in 1971 and has handled bottled carbonated drinks (Figure 11). Thereafter, the production line that handled cans used as containers was added, and the capacity diversified. The demand for the sports drinks increased since the 1980s, and the line of a large PET constructed in

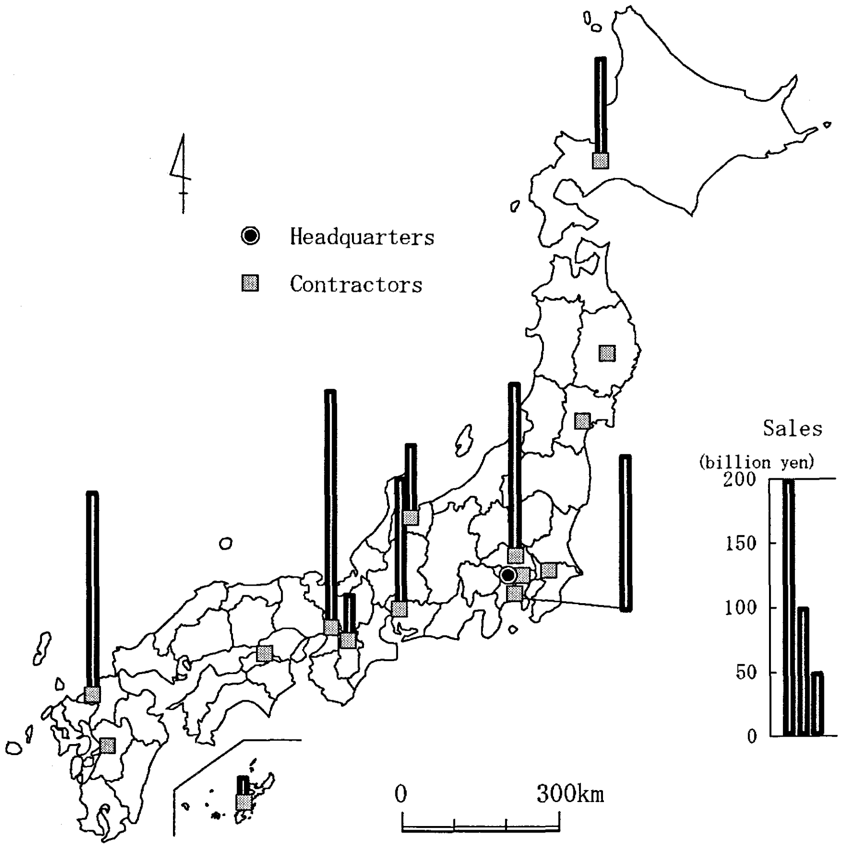


Figure 10 Sales of Corporation A's contractors

Note: Data in 2000-2002 were used.
Corporation which sales are not shown has no data.
(Source: Data from Corporation A)

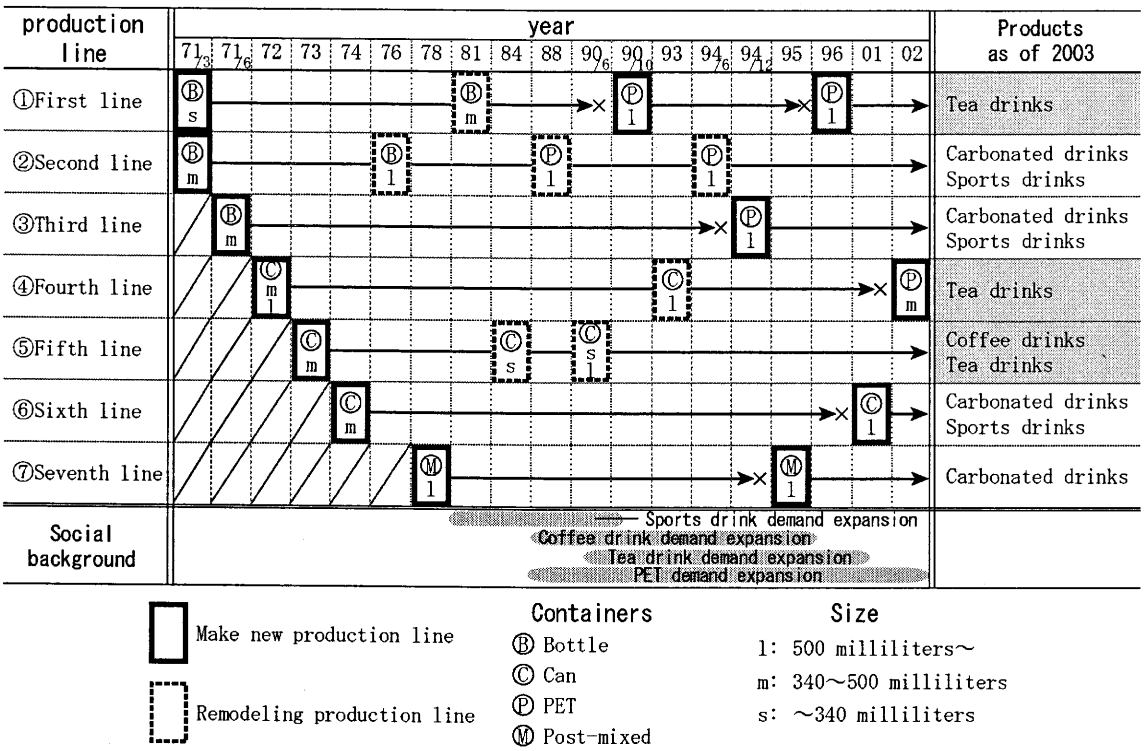


Figure 11 Change of production lines in Ebina plant

(Source: Data from Corporation A)

1988. Further, the demand for coffee and tea increased since the latter half of the 1980s, and their manufacturing was also started. Moreover, since the demand for light portable PET containers had increased, the line was remodeled in the Ebina plant. In other words, the strategy of the Ebina plant is machine enhancement, production line diversification, and difference in the size and standard of containers to satisfy consumer needs that increase every year. In addition, to satisfy consumer needs, multiple products such as the sports drinks, coffee, and tea, is carried out rather than the production of only carbonated drinks.

2. Processes of Organic Waste Discharge by Corporation A

There are seven production lines in the Ebina plant as of 2003 (Figure 11). The production line differs depending on the type of product and container. The first, fourth, and fifth lines discharge the organic waste manufactured during the production of tea and coffee.

The raw materials for the products manufactured at the plant are ordered and procured from the headquarters. Organic waste is discharged when the extraction of the raw material, which is the first stage of production, is mixed. The liquid is filled into the container in the second stage of packing. In the third stage, the product is finally packed in cases. In each production line, the organic waste is temporarily discharged in the extraction mixture process into a dregs hopper[18] through piping; there are four dregs hoppers. The first line that treats the 2 L PET has two dregs hoppers of approximately 27 tons or less. These two are used for oolong and other teas. The fourth and fifth lines have dregs hoppers that store 27 tons or less and 18 tons, respectively. These dregs are from coffee mixed with tealeaves. After the extraction of the raw material —approximately 1.67 times for coffee and approximately 1.90 times for tea leaves—the residues are discharged depending on the weight of the raw material prior to processing. The dregs hoppers reach their volume limit in a day due to the presence of bags of water deposition of residues of coffee and the tea leaves after the production process. Therefore, the dregs hoppers are arranged in a position that provides easy access to the waste contractor's vehicle. The contractor then receives the stored organic waste throughout the day.

3. Structural Changes in Organic Waste Disposal

3-1. Changing Processes of Organic Waste Disposal

The production in the Ebina plant has been constant from 1997 to 2002 (Figure 12). The product details are uncertain due to the restriction of data. However, the tea production increases according to the interviewing data because of the increase in tea preference in recent years. In other words, the amount of disposed organic waste increases in the case of residues of tea

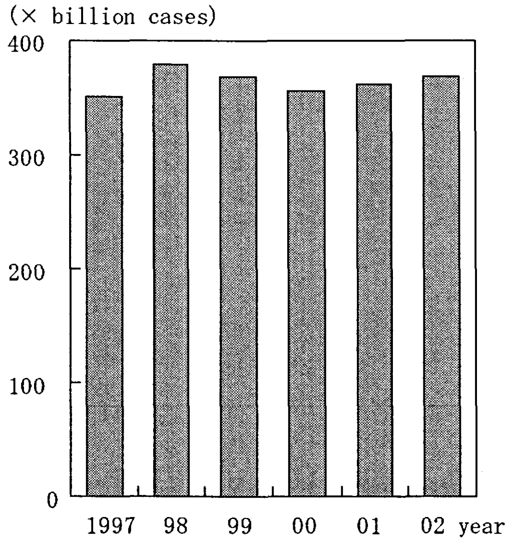


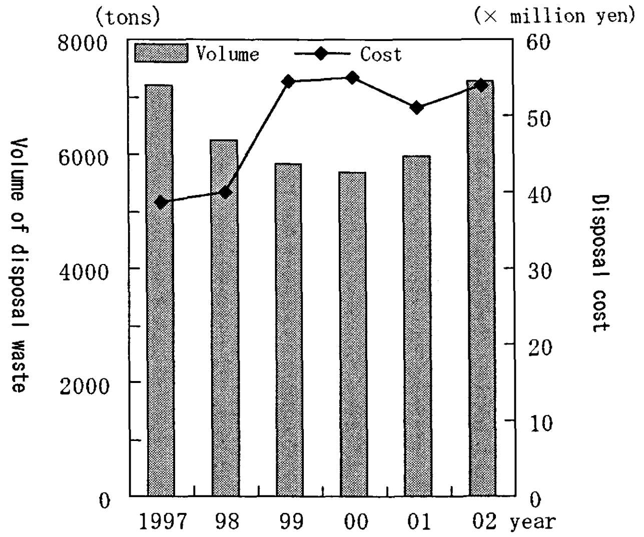
Figure 12 Production in Ebina plant, 1997-2002

(Source: Surveyed by author)

because its amount is relatively large. The amount of discharged organic waste increases in the years when the demand for coffee and tea is high (Figure 13a).

On the other hand, the disposal cost of organic waste from 1997 to 2002 is not proportional to the disposal quantity. The reason behind this is the change in the disposal method of organic waste in the Ebina plant (Figure 13b). The waste disposal has been consigned to the industrial waste contractors since the beginning of operations in the Ebina plant. Neither the amount nor the destination was clear; however, a part of botanical waste at that time was utilized for compost making. Moreover, the sludge was disposed into the sea. In the disposal method without a thorough management, the cost was suppressed to an amount that is lesser than the present amount. The control of waste generation and the promotion of recycling were performed at the beginning of the operation of the plant depending on the WDPC Law that had been enforced in 1970. However, the recycling cost of the disposed material was not determined because this law did not provide the responsibility or management for the waste that the entrepreneur has discharged.

Recycling of organic waste was begun in the production plant between 1999 and 2002. During recycling, the discharged organic waste was carbonized and organic charcoal was manufactured and sold to the charcoal corporation as a sub-raw material. However, the disposal cost at this time increased in inverse proportion to the disposal quality because it of the enormous cost incurred for a)Cost and volume of organic waste



b)Change of waste management

Time	Disposal site	Disposal method	Ratio of recycling	Cost
Before acquired ISO14001 (1984～2001/5)	Waste contractors	Plant residue･･･unconfirmed Sludge･･dumping at sea	Below 50%	low
Application period (1999～2002)	own plant	Amendment of charcoal was generated and sold	Unknown	high
After acquired ISO14001 (2001/5～)	Waste contractors	Plant residue･･･composting Sludge･･･composting/concrete material	100%	high

Figure 13 Change of waste management in Ebina plant
(Source: Surveyed by author)

the recycling equipment and the maintenance expense. This plant was approached immediately before the acquisition of environmental certification and an environmental appeal was made for the environmental certification. It can be considered that the years are shift period to management thought about environmental issues. In addition, in 2000, the Basic Law for Establishing the Recycling-based Society was enacted and the law concerning recycling, such as recycling of the container wrapping and food waste, was reinforced. The action of Corporation A can be considered to be an emergency response to these Laws. According to interviewing data, recycling in the plant was performed for only two years due to the problems of facilities maintenance, management, and cost.

In addition, the cost again increased because Corporation A acquired an ISO14001 environmental certification in May 2001. The disposal expense increased because the industrial waste contractors recycled the entire organic waste. Additionally, in the revision of the Waste Disposal and Public Cleaning Law in 2001, all the management practices prior to final waste disposal have been made obligatory for all waste generators, including Corporation A. This law has been enforced in the cases of pollution due to waste and the illegal disposal management practices. Therefore, the waste generators are obligated to manage the flow of waste based on the manifest[19)]. The waste generators along with waste collection and conveyance contractors and disposal contractors, who have obtained the permission, manage the quantity of delivery in each stage of waste disposal. In the Ebina plant, the recycling of waste is required. The generated waste should be managed by involving waste collection and conveyance contractors and waste disposal contractors. Transactions with the contractors often become expensive due to the high quoted price, thus increasing the disposal cost under the assumption that waste is recycled. A major portion of the recycled organic waste is converted to compost.

Thus, the disposal structure of the waste discharged by Corporation A changed dynamically due to the acquisition of the ISO14001 environment certification and the laws enforced on waste generators.

3-2. Relationship between Corporation A and Industrial Waste Contractors

In this section, the relationship between the Ebina plant of Corporation A and industrial waste contractors has been considered. The industrial waste contractors have been described first. Generally, the industrial waste contractors are classified into the following three types: (1) contractors specializing in waste collection and conveyance, (2) contractors specializing in waste disposal, and (3) contractors involved in waste collection and conveyance and disposal. In this study, only the contractors involved in preparing compost have been considered and are referred to as "waste-recycling contractors" instead of waste disposal contractors. Further, "industrial waste contractor[20]" is the generic name for all the contractors involved in waste management.

Two waste collection and conveyance contractors from Kawasaki and Yokohama are involved in the management of the organic waste discharged from the Ebina plant (Figure 14). The commission of contractor 1 is high because waste recycling is also carried out in addition to waste collection and conveyance. The waste commission of each contractor, however, changes according to the quality of the discharge from the Ebina plant. The organic waste is delivered to the waste-recycling contractors by each of the waste collection and conveyance contractor. Figure 14 shows that waste is transported through a large area, including Saitama and Yamanashi Prefectures, even though the waste collection and conveyance contractor is based in Kanagawa prefecture. The waste-recycling contractor commercializes the compost and sells the delivered organic waste.

The transaction between the Ebina plant of Corporation A and waste collection and conveyance contractors provides the contractors with the opportunity of sales promotion. These transactions have continued since coffee manufacturing started (Table 2). The waste-recycling contractors were associated with the Ebina plant due to the introduction of waste collection and conveyance contractors. As mentioned above, the waste discharging industry should deal with the waste collection and conveyance contractors and waste-recycling contractors who have obtained waste permission. The waste collection

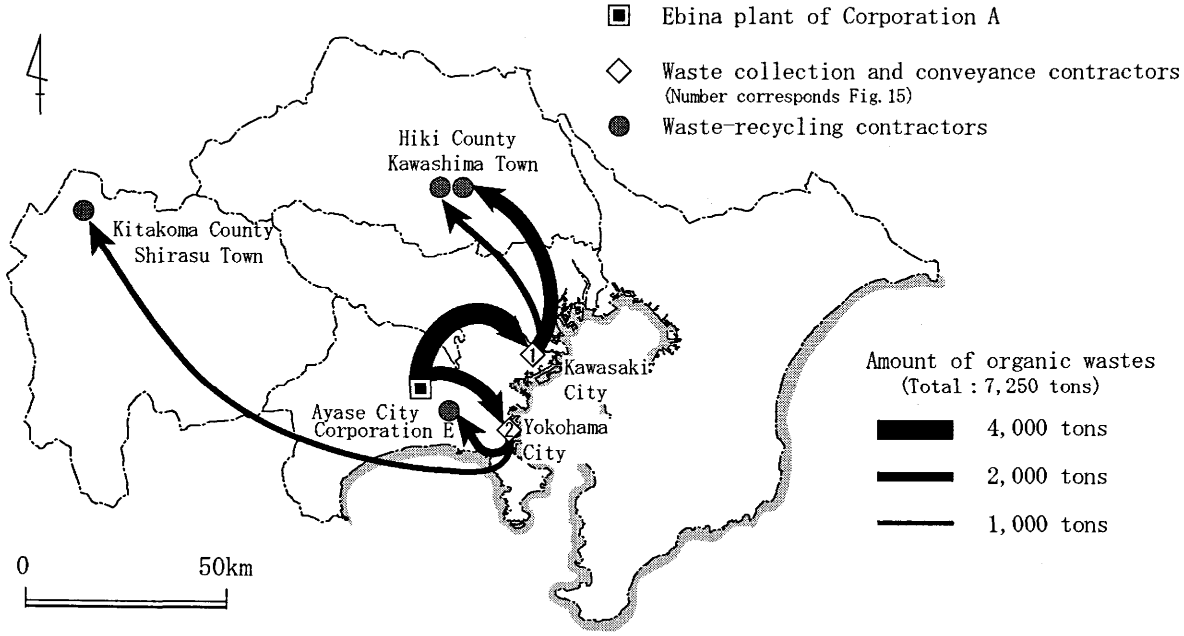


Figure 14 Flow of organic waste discharged from Ebina plant, 2002

(Source: Surveyed by author)

Table 2 Relationship between Ebina plant and waste contractors

		Transactions start year	Transactions motive
Waste collection and conveyance contractors	1	-	-
	2	1984	Sales promotion
Waste-recycling contractors	1	-	Introduction of waste conveyance contractor 1
	2	-	
	3	2002	Introduction of waste conveyance contractor 2
	4	-	

Note: [-] is unknown.

(Source: Surveyed by author)

and conveyance contractors obtain prior information on the increase in discharge in the production lines from the information network of industrial waste contractors. They then approach the waste-recycling contractors, and announce the costs to the plant discharging the waste. As a result, the plant discharging the waste can save the time spent in looking for the contractor of waste recycling. On the other hand, the waste collection and conveyance contractor has the advantage of making the contract. There is a strong network between the waste collection and conveyance contractors and waste-recycling contractors in the areas where a large amount of waste is generated. In order to accomplish the business smoothly, the contractor who handles industrial waste exchanges information with the other contractors. The waste collection and conveyance contractor builds an original network using his influence among the plant discharging the waste, which is the source of profit and the waste recycling contractor.

The details of transactions of organic waste are continuously considered. In the Ebina plant, the charge time varies depending on the waste collection and conveyance contractors (Figure 15). One contractor charges for 24 h, while another contractor charges for the daytime, when the production line is chiefly operated. In the Ebina plant, the hopper can stock a maximum of approximately 100 tons of waste. However, for smooth operation of the production line, two waste contractors have to work five times a day on an

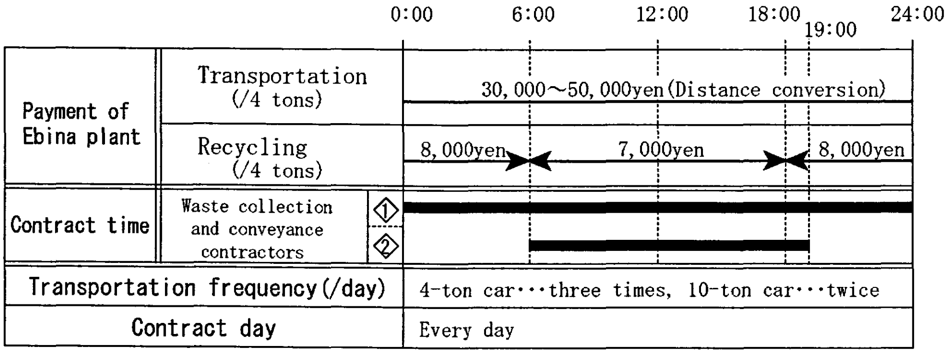


Figure 15 Transaction with organic waste dealers in Ebina plant, 2003

Note: Numeral of waste contractor corresponds Fig.14.
Recycling charge is the average of all kinds of organic waste.
(Source: Surveyed by author)

average. Further, the Ebina plant pays transportation and recycling charges to the transactions contractor as a part of the organic waste disposal cost. Transportation charges are based on the distance and time of transport. The recycling charge of the waste recycling contractor varies with the type of waste. For example, the recycling charge is high if the waste has a high amount of moisture and if sophisticated skills are necessary. The plant discharging waste prefers a contractor with whom inexpensive transactions can be made. However, in order to avoid risks, it cannot use a single contractor. Further, for smooth operation of the production line, a contractor should be also employed in the night. The discharge side that generates large amounts of waste needs contractors capable of recycling it or waste collection and conveyance contractors who have connections with the recycling contractors. There is a great demand for organic waste. There are, however, no large-scale recycling facilities that can handle large amounts of waste in the periphery of the plant. Hence, there is an increase in transportation charges. Therefore, the industrial waste contractor is more important than the discharge side in these transactions involving organic waste disposal.

4. Corporate Strategy and Evaluation in Organic Waste Management

Since the establishment of the Ebina plant, it has improved its service and contribution to the environment by implementing the international quality assurance system ISO9002 certification and food safety management standard (HACCP) along with other soft drink manufacturers (Table 3). Additionally, the plant attempted to obtain environmental management certification (ISO14001) by the environmental management by which the organic waste disposal structure would undergo a major change. There has been an active attempt to reduce the environmental stress in its own plant.

The corporations basic principles are the result of external factors such as increasing public concern for the environment and laws enforced for waste management; these factors influence the corporate activity of Corporation A and its Ebina plant. The corporation is expected to improve its corporate image and reduce environmental stress through improving its economic effectuation by acquiring an environmental certification as part of the strategy. However, the acknowledgment level of the environmental certification system is still lower than that required to improve the corporate image in accordance with its aim. In addition, the corporate identity is not emphasized through this certification system because the acquisition of the certification is generally associated with the waste discharge corporations[21]. As part of its regional contribution, the Ebina plant supports positive environmental preservation activities not only through the certification system but also through the distribution of pamphlets, participation in environmental events, and offering of environmental education materials. However, consumer feedback regarding

Table 3 Management strategy of environmental stress reduction in Ebina plant

Date	Matters
1971/3	Plant operation starts
1984/6	Coffee production starts
1990/6	Tea production starts
1998/9	Acquiring of ISO 9002 certification
1999/4	Introduction of carbonization system of tea dregs
2001/5	Acquiring of ISO 14001 certification
2002/3	Acquiring of HACCP certification
2002	Abolition of recycling of carbonization system

(Source: Data from Corporation A)

the cost-effective measures undertaken is extremely low. Moreover, the recycling increased the disposal cost by approximately 1.5 times, which is discussed in the above paragraph. This is because the transactions contractor determines the disposal cost. Therefore, growth in earnings has fallen below expenses by the management that considers the environment.

Thus, in the short-term, the acquisition of the environmental certificate as part of the corporate strategy is not closely related to an improvement in consumer's buying intention and caused the decrease in the economic effectuation of the corporation. This situation is similar to that faced by other corporations that acquires ISO certification (Nosei journalist no kai 2000). The change in waste processing techniques in Corporation A was due to the ISO certification. However, all the corporations that discharged 100 tons or more of organic waste per year have restricted their disposal method by the WDPC Law. The disposal cost in all these corporations, including Corporation A, has increased depending on the waste contractor. However, the potential advantages are high following changes such as management stability and the improvement in the acknowledgment level to the consumer's interests. The corporation is presently planning a reduction in costs; this includes decreasing the moisture content of waste because the organic waste disposal cost is calculated by weight conversion. Decreasing the moisture content of waste is advantageous for the corporation due to decrease in the disposal cost and ease of waste management. Moreover, the corporation considers that it is necessary to initiate environmental preservation activity that stimulates the consumers buying intention.

As mentioned above, consumer needs and laws as external factors greatly control corporate activities. As a result, although the waste management techniques have changed based on the policies of the corporation, the formation of the disposal structure depends on the waste collection and conveyance contractor.

CHAPTER 4

MECHANISM OF RECYCLING OF ORGANIC WASTE

1. Introduction of Corporation E

The waste management structure in a food manufacturing industry was examined in the previous chapter. This chapter examines the recycling of organic waste discharged by Corporation E, which is a waste contractor located in Ayase City, Kanagawa Prefecture (Figure 9).

The corporation that became the antecedent of Corporation E was established in 1965. The corporate principles of the corporation included recycling of resources. Initially, their main business was the collection, exchange, and salvage of toilet paper using a two-wheeled cart. A limited corporation was established after permission for the collection and conveyance of industrial waste was obtained from the prefecture in 1983. The corporation began collecting organic waste in 1986. Since the corporation obtained waste disposal permission, the business expanded into transportation and recycling. In 1994, the eldest son assumed the position of president of the corporation. In the following year, the second son established Corporation E. Corporation E specialized in waste collection, compost treatment, and sale of organic waste.

The development of organic waste-related business in Corporation E is roughly divided into three stages. The first stage was from 1986 to 1987 when the supply destination started stagnating with organic waste. The second stage was from 1988 to 1999 when composting was started due to rapidly decreasing supply destinations. Radical composing was then started. The third stage started in 2000 when transactions with several corporations were started to handle of different types of wastes. The characteristics of organic waste collection and delivery and the recycling process are analyzed with respect to the three stages in the next section.

2. Business Management of Corporation E

2-1. The Incunabulum Stage (1986~87)

The only collection place of organic waste in the first stage in Corporation E was the soft drink manufacturer, Corporation D (Figure 16). Corporation E had been collecting used paper and wrapping paper discharged from Corporation D prior to collecting organic waste. Therefore, Corporation E began the collection and conveyance of organic waste in order to understand the working of the coffee production line in Corporation D. Since it was a business, only the collection and conveyance of waste without processing was carried out.

The raw material was first carried out in four compost centers of the agricultural cooperatives, which existed in the same affiliate as Corporation D. These compost centers are introduced from Corporation D. Waste was sold as a fermentation accelerant of animal excreta. However, since the waste contained

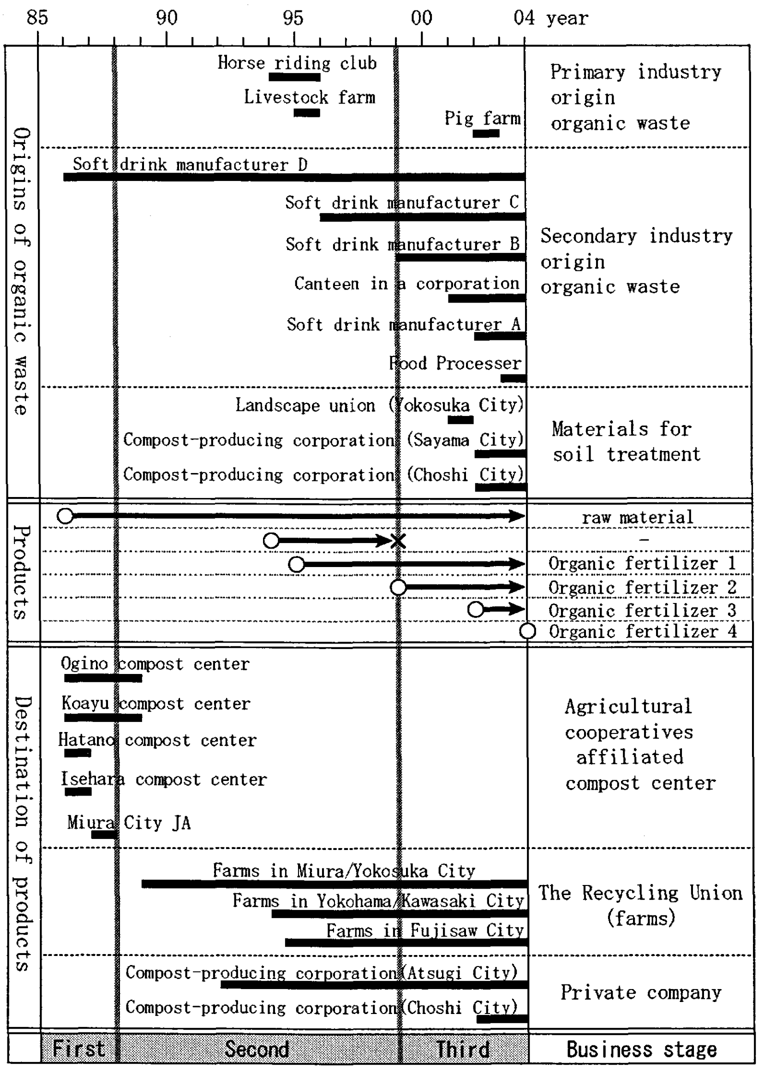


Figure 16 Transition of transactions of organic waste in Corporation E

(Source: Data from Corporation E)

excessive moisture, it was not suitable for this use. Since the number of customers decreased gradually, Corporation E registered for the waste exchanging system of Kanagawa Prefecture. As a result, Corporation E started dealing with the Miura City agricultural cooperatives (Miura City JA). However, transactions were discontinued within a year due to the high moisture content. Therefore, the number of customers gradually decreased because the commodity did not suit their needs.

2-2. The Conversion Stage (1988~99)

After losing the supply destination, Corporation E started dealing with the farmers' organization with an introduction from the Miura City JA staff. This organization is the *"Miura Hantou Yukibutsu Saiseiriyoukumiai"* (Recycling Union). Despite providing free delivery, there was a further sharp decrease in the number of customers due to high moisture content and damage to crops. Even if it entered the second stage, Corporation E could not increase its carrying origins because of few customers. The management of business at Corporation E also became difficult due to a decrease in the number of customers. Hence, Corporation E continued to sell untreated waste. At the same time, with the cooperation of the leader of the Recycling Union, it investigated the potential uses of coffee dregs. They found that using a combination of coffee dregs with other wastes was better than using coffee dregs alone because in combination the dregs fermented easily and good quality compost was obtained. They also developed moisture-adjusting methods. In 1989, the Recycling Union was formed, and the customers of Corporation E shifted from agricultural cooperatives-affiliated compost centers to a big farmers group in the same year. The improved waste treatment methods and the cooperation of the farmers influenced the business management of Corporation E. In 1991, a treatment area of 330.6 m^2 was constructed for the waste treatment with the help of the Recycling Union. The coffee and tea dregs were mixed and delivered without fermentation after adding effective bacteria.

Transactions with the compost-producing corporation, which was a similar corporation in Atsugi, were begun in 1992. This corporation chiefly treated domestic animal excreta; therefore, it attempted the mixing of coffee dregs with the excreta for original compost manufacturing. On the other hand, Corporation E had to carry out the composting when the Recycling Union did not use these raw materials in order to avoid stagnation of the stock. Inevitably, these transactions were approved.

The demand for the moisture-adjusted commodity increased, and Corporation E began radical composing. Corporation E initially manufactured the sludge compost fertilizer that was prepared from the organic sludge discharged by the soft drink manufacturer, Corporation D.

Corporation E collected horse dung and tea dregs and attempted to prepare good-quality compost. Its own treatment area of 1050 m^2 was constructed in 1995. Several industrial estates are situated around Corporation E, and a small distance separates it from the residential quarters. An advanced device was installed in the area of treatment in view of the amount of discharge and complaints from the local population regarding the foul odor.

Therefore, Corporation E built its base of business development in order to meet the customer needs by product development, etc., in the second stage. Moreover, it strengthened its connections with the compost-producing corporation to supplement excesses and deficiencies in the compost raw material.

2-3. The Expansion Stage (after 2000)

With the installation of the treatment plant, there was a continuous increase in both acceptance and quality of compost in the second stage. Additionally, waste from the food manufacturing industry increased rapidly since the enforcement of the WDPC Law in 2000. Transactions with organic waste from the primary industry origins did not continue. In contrast, organic waste of the secondary industry origin has increased in the management of Corporation E. Diverse types of wastes such as coffee dregs and tea dregs as well as sludge and garbage were used. Consequently, Corporation E developed new products depending on the type of waste such as compost from fermented coffee dregs, high-quality sludge fertilizer, and organic fertilizers from garbage. Thus, the diversification of management was practiced to handle the compost demand. Corporation E obtained soil improvement materials such as prune branch chip and bark compost from the same traders.

Corporation E uses the trader information network and marketing research in order to secure the carrying origin. Corporation E then aims at the acquisition of waste by understanding the needs of the organic waste generators. Corporation E has obtained permission from the prefecture for the collection and conveyance, and waste disposal. Therefore, it is easy to secure the carrying origins by negotiation. In certain cases, Corporation E could be requested to treat the waste only by other collection and conveyance companies. Corporation E undertakes only the treatment of waste discharged by Corporation A and a canteen of a manufacturing enterprise.

Most of customers were farmers of the Recycling Union, with whom business relations continued from the second stage. It has gradually expanded from Miura Peninsula to the farmers in Yokohama and Kawasaki Cities. Further, a new agreement for the mutual supply of compost raw material was formed between Corporation E and the compost-producing corporation in Choshi City. This agreement is similar to that with the compost-producing corporation in Atsugi with which it has transactions since the second stage. The above transactions were made possible by the introduction provided by the waste collection and conveyance contractor 2 (Figure 14) who has a contract with Corporation A.

The products, which satisfied customers, were enhanced by the diversification of the carrying origins and waste types, as indicated above. Moreover, the network of the waste contractors strongly influenced the transactions of organic waste.

3. Spatial Characteristics of Organic Waste Collection and Delivery

3-1. Origins of Organic Waste and the Amount Collected

Corporation E has collected organic waste from eight corporations as of 2002 (Figure17). The carrying origins are not only situated around Ayase City, where Corporation E is located, but also in a large area in Kanagawa Prefecture. Recently, Corporation E has started transactions with the same traders based in Sayama and Choshi Cities to enhance compost manufacturing. The carrying origin is located along the expressway, facilitating the transport of waste. The Corporation E deals with industrial wastes such as tea and coffee dregs, garbage, and pig dung, which are discharged from the soft drink manufacturing plants in corporations A, B, C, and D. In addition, a variety of wastes, including diatom soils, prune branch chips, adsorption materials such as the bark compost, and dry materials are also collected. Thus, several good-quality products, which are prepared by mixing a variety of wastes, can be

	Origins of organic waste	Organic waste
1	Corporation A	Tea/coffee dregs
2	Corporation B	Coffee dregs, sludge, diatomite
3	Corporation C	Tea/coffee dregs, orange pericarp, diatomite
4	Corporation D	Tea/coffee dregs, sludge
5	Pig farm	Pig manure
6	Compost-producing corporation	Prune branch chip
7	Canteen in a corporation	Garbage
8	Compost-producing corporation	Bark compost

(A-D: Soft drink manufacturer)

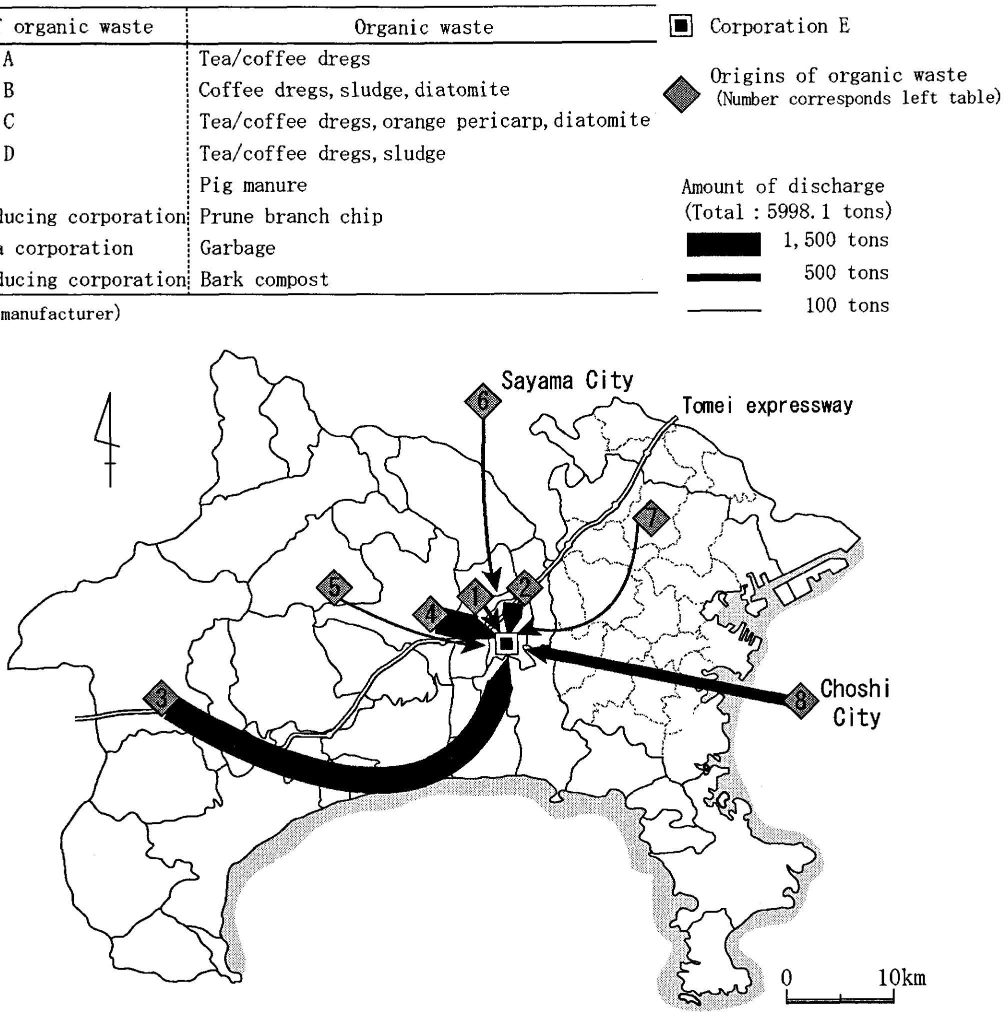


Figure 17 Origins of organic waste collected by Corporation E, 2002

(Source: Data from Corporation E)

supplied.

In direct transactions with the carrying origins, it was agreed that the waste transportation business would be entrusted to Corporation E. On an average, waste is collected in four-ton cars once or twice a day. Corporation E owns one ten-ton car, one eight-ton car, and three four-ton cars. Four drivers collect waste throughout the day on the business days (Monday to Saturday).

The nature of organic waste collected changes throughout the year. The production of tea and the fruit-based beverages increases from the beginning of summer to fall; this was particularly observed in 2002 (Figure 18). Therefore, a large amount of waste was discharged from the soft drink manufacturing plant. Further, the amount of waste carried by Corporation E increased in October by the acquisition of two new origins of organic waste. This transaction is due to improve the quality of product and adjust the quantity with other compost-producing corporations. The amount manufactured by waste generators strongly influences the carry in amount of Corporation E.

3-2. Destination of Products and the Amount of Carry Out

In this chapter, the carry out destinations of the products that were regenerated in Corporation E are examined. A majority of carry out destinations is distributed on the east side of the large consumption area associated with it (Figure 19). The customers mainly include farmers and

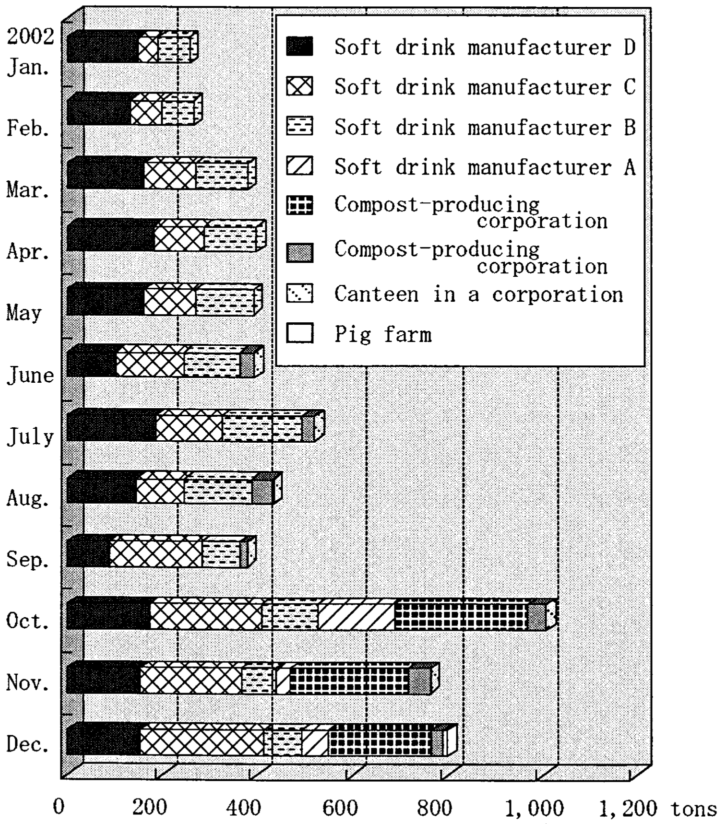


Figure 18 Monthly carry-in of waste in Corporation E, 2002

(Source: Data from Corporation E)

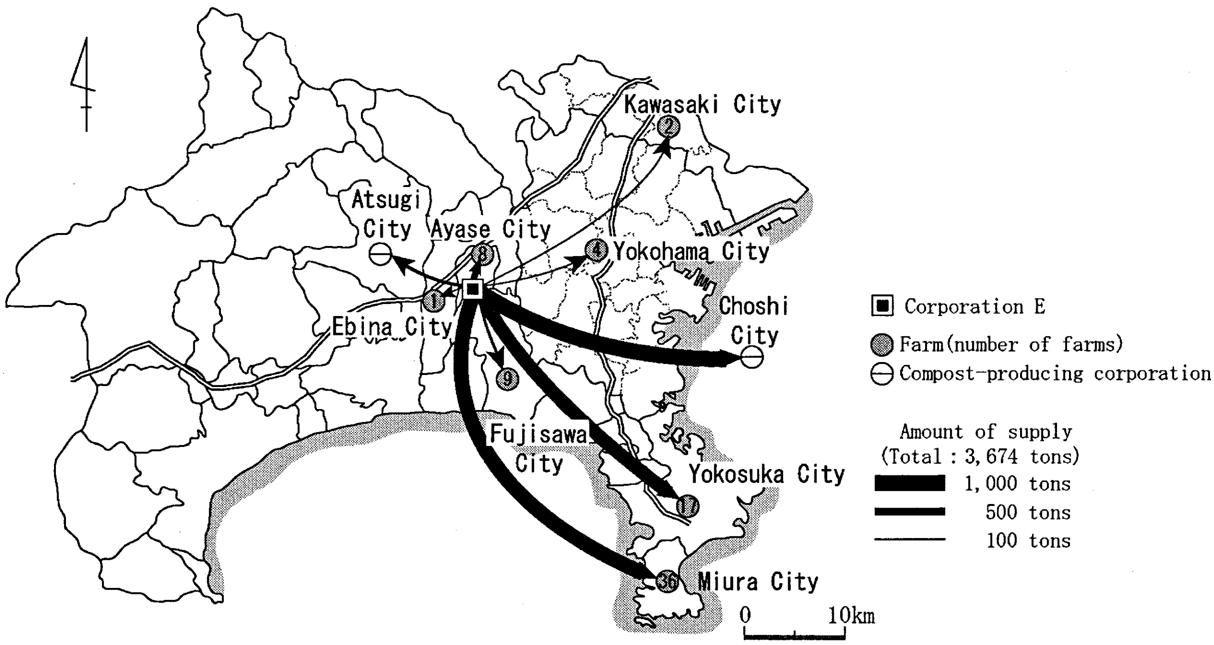


Figure 19 Destination of compost and products in Corporation E, 2002

(Source: Data from Corporation E)

compost-producing corporations that are based in and around the prefecture. Among these, 54 farmers in Miura Peninsula and the trader in Choshi City are particularly important. A majority of the farms produce and sell vegetables or fruits. A small number of livestock farms produce compost by mixing domestic animal excreta discharged in their farms with the compost raw material of Corporation E.

Moreover, according to the data collected in 2002, the amount of product carried out from Corporation E varied with time (Figure 20). The amount of product carried out was large from summer to autumn. Since several customers were farmers, the amount of product carried out reflects the crop cultivation season. For instance, the amount of carry out to Miura and Yokosuka Cities is large in early spring and autumn when compost is required in fields. Similarly, since the compost-producing corporation in Choshi City began transacting with Corporation E in June, the amount of product carried out is large from June to December. There have been a large amount of transactions with this corporation from October through December when the amount of collecting of Corporation E was particularly large.

Corporation E manages the collection of organic waste as well as its transportation to the production area. Corporation E maintains flexibility of the delivery service with respect to the amount and time, according to customers' needs. In the peak demand season, products are delivered to the farmers each

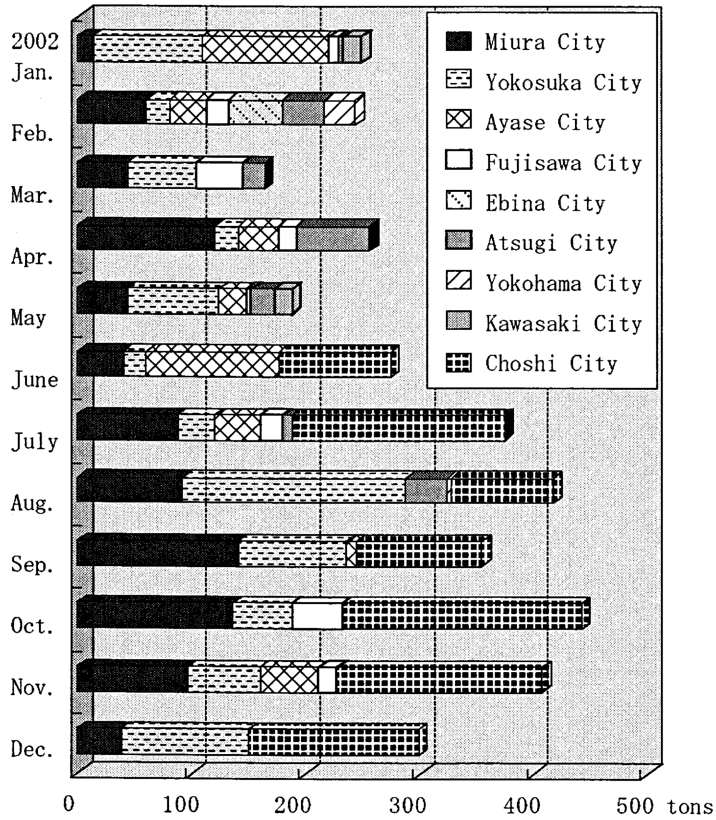


Figure 20 Monthly carry-out of compost and products in Corporation E, 2002

(Source: Data from Corporation E)

fields in four-ton cars three times a day, and to the compost-producing corporation in ten-ton cars one to two times per day.

As mentioned above, the customers of Corporation E are spread over a wide area. Therefore, considering the transportation frequency and the number of drivers, efficient delivery was managed with great difficulty. Furthermore, the instability in the transaction supply and demand balance was compensated.

4. Maintenance of Business Management

4-1. Recycling Process of Organic Waste

Corporation E provides only primary fermentation as the recycling treatment. The customers do the secondary fermentation after the product is delivered. As of 2003, the organic waste collected by Corporation E was chiefly commercialized and delivered to the customer in four forms. The first is organic fertilizer 1; this compost produces by a recycling process that requires the shortest time (Figure 21a). This was developed in the first stage when Corporation E began manufacturing the compost. A simple compost raw material based on the coffee dregs is used. The raw materials also included prune branch chips for moisture adjustment and diatom soil for absorption. In the fiscal year 2002, the major carry out destination was the compost-producing corporation in Atsugi City. However, it was also carried out to the farmers in Yokosuka City from summer to winter. The amount of carry out forms 7.4% of

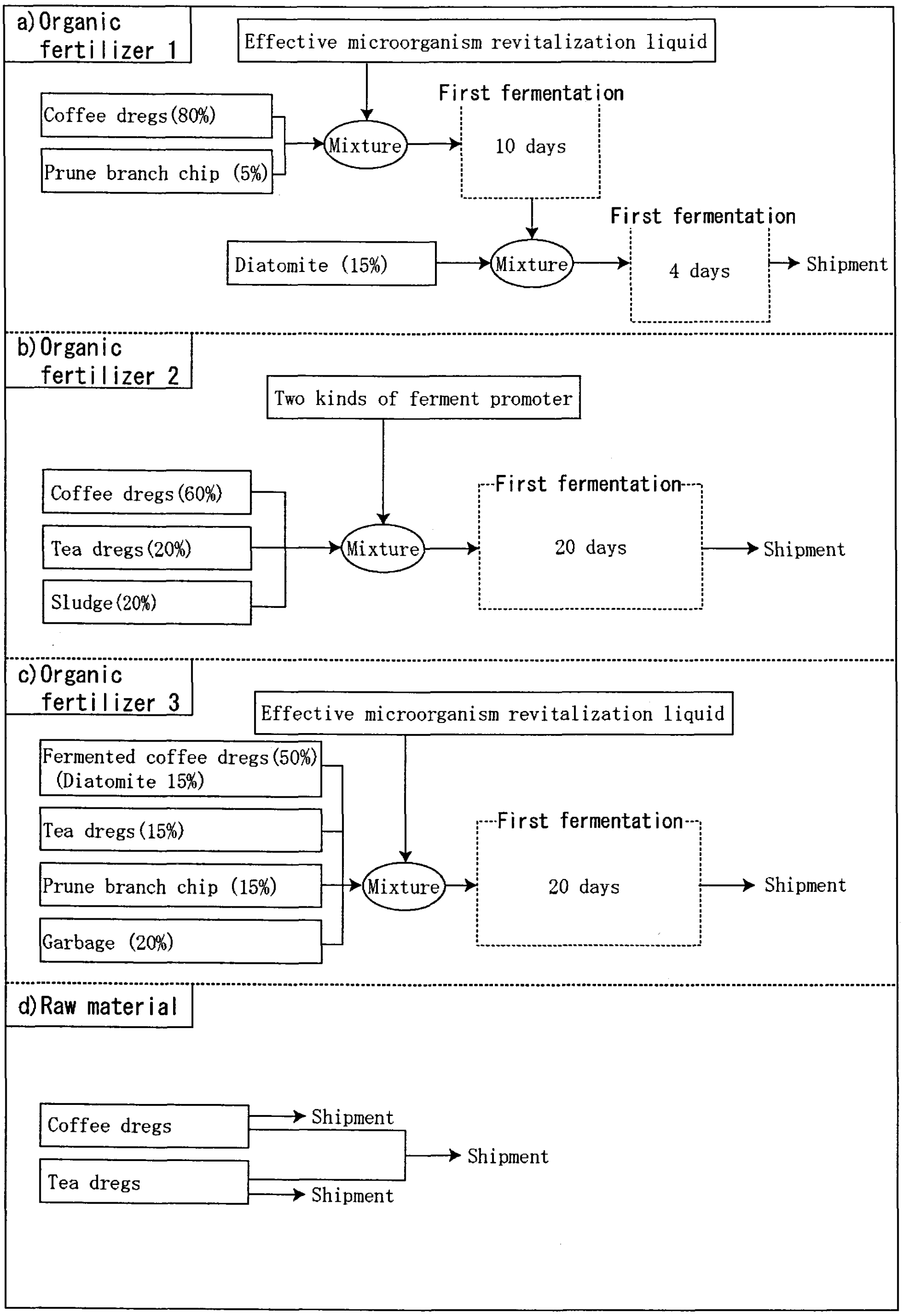


Figure 21 Procedures of composting treatment in Corporation E, 2003

(Source: Data from Corporation E)

the total amount manufactured in the year, i.e., 272 tons.

The second product is organic fertilizer 2 that forms the largest proportion of the recycled product (Figure 21b). This product along with the sludge addition fertilizer forms 55.7% of all the products of Corporation E. In 1999, composting using good-quality sludge, which was obtained from the soft drink manufacturer Corporation B, was begun. Mixing sludge with coffee dregs performed composting. The Corporation E handled organic waste when the company was established. Therefore, the amounts of the coffee and tea dregs were insufficient due to change in carrying origin. Sludge, which is discharged by soft drink manufacturers, started being used as the substitute. Sludge has high moisture content, and harmful elements could be present in it. It is transported from the manufacturer to Corporation E in the form of dehydrated cakes. Sludge produces stench and cannot be easily fermented. Hence, for the generation of products using sludge, a special composting process, such as the use of fermentation promotion materials or mixing with coffee, which has effects to bring about deodorization. Moreover, it is feared that sludge-based fertilizers may contain heavy metals. Therefore, consumers have avoided using sludge-based fertilizers. They were commercialized with the revision of the Fertilizer Regulation Law in 2000. According to the law, an official standard was provided concerning the quality of fertilizer elements and harmful elements in fertilizers. As a consequence, the demand for sludge-based fertilizer increased. This fertilizer was found to be suitable for outdoor vegetable crops. The sludge fertilizer is superior in its composition and has taken the place of manure and organic fertilizers (Date and Shiozaki 2001, p218). This product uses by farmers in Miura Peninsula (69.1%), Ayase City (19.3%), and in one more city (11.6%). Therefore, it can be said that the farmers prefer organic fertilizer 2.

The third product is organic fertilizer 3 that is manufactured by the fermentation of a mixture of several types of organic wastes for approximately 20 days (Figure 21c). This product was developed in 2002 mainly from garbage, which was obtained with permission from the canteen residue in the manufacturing corporation. The operation process and the mixture ratio of the raw materials are more complex than those of fertilizer 1 and 2 because different types of wastes are mixed with the garbage whenever composting is performed. It is necessary to remove wastes such as chopsticks and metals. Therefore, it is difficult as well as time consuming to maintain a steady quality because the content of waste changes every day. Hence, the amount of the product carry out is the lowest (6.3%) among all the products. The only supply destination is a farm near Miura Peninsula.

The fourth product is untreated organic waste (Figure 21d). The product is delivered either as a mixture (with coffee and/or tea dregs) or as untreated waste (none of the raw materials are treated). The supply destinations are either farmers who themselves prepare the compost or compost-producing corporations. The amount of handling of this compost raw material approaches 30.3% of the entire Corporation E. Further, 94.3% of this untreated raw material is transported to the compost-producing corporations. The direct carry out of untreated compost raw material regulates demand and supply of Corporation E.

When considering the compost raw material and the products handled by Corporation E, coffee dregs have been assumed to be the major raw material. Tea dregs originally contain 80–90% moisture. Therefore, coffee dregs, which contain 60% moisture, are comparatively easy to ferment[22] and have a deodorant effect. Corporation E collects and mixes various organic wastes in order to maintain the moisture levels, bacterial load, and nutrient balance of the product. The organic waste alone obtained from the carrying origin cannot be used alone as a supplement. It has to be replenished with waste obtained from compost-producing corporations. As a result, the compost-producing corporations have efficiently controlled fermentation and odor and ensured a high-quality product by this mutual supplementation of excess amounts and deficiencies of organic waste.

4-2. Changing the Quantity of Organic Waste Handled and Its Inventory Adjustment

As mentioned previously, it is clear that the regeneration treatment process varied depending on the types and amounts of waste collected. Figure 18 shows the changes in the types and amounts of collected organic waste in a short period. From the viewpoint of the waste contractor, the reasons are securing of a necessary amount of waste, business expansion, and disposal cost. In general, the distance decides the transport cost of waste, as in the case with Corporation A. However, the disposal cost varies depending on the type of waste. The disposal cost of coffee dregs in terms of unit price of treatment per kg is the lowest. The market price of tea dregs is 1.3–1.5 times that of coffee dregs and sludge is five times that of coffee dregs. Despite the requirement of advanced techniques for processing, accepting sludge leads to an increase in income. Transactions of waste differ from the usual market transactions. The invoice is issued at the waste collection stage in the industrial waste disposal. This is referred to as "manifest." However, the untreated waste is stocked if the merchandise turnover rate is poor and the utilization rate of the processing machine is low. Therefore, its sale is not possible, except for alternate disposal by illegal means. Hence, the stock of the commodity exerts an important influence on the management of waste contractors.

Since the productive structure with respect to the discharge of organic waste is closely related to the consumption tendency, the quantity and quality of organic waste has changed. The demand period of the product varies because most of customers are farmers; it also depends on the characteristics of the product. Therefore, the demand and supply balance of organic waste generally becomes unstable in the compost-producing corporations. In general, the area available for treatment in compost-producing corporations is limited. Hence, only a constant amount of product can be stored. For instance, only less than 409.7 tons of the products can be stored in Corporation E (Figure 22). Waste should be regularly recycled and a constant rate of disposal and shipment should be maintained in order to restrict the amounts of stored product. Accordingly, inventory adjustment is essential for the compost-producing corporations. In that case, the network of waste contractors plays the most important role in inventory adjustment.

As mentioned above, the compost-producing corporation exchanged waste with traders from whom the organic waste was obtained in order to maintain the amount of moisture and nutrient balance of organic waste. The compost-producing corporations are involved in the mutual supplementation of excess amounts and deficiencies of organic wastes. This resulted in the amount of waste exceeding the maximum storage capacity from October to December in Corporation E (Figure 22). Therefore, the compost raw material was carried out to the highly cooperative compost-producing corporations in Choshi and Atsugi

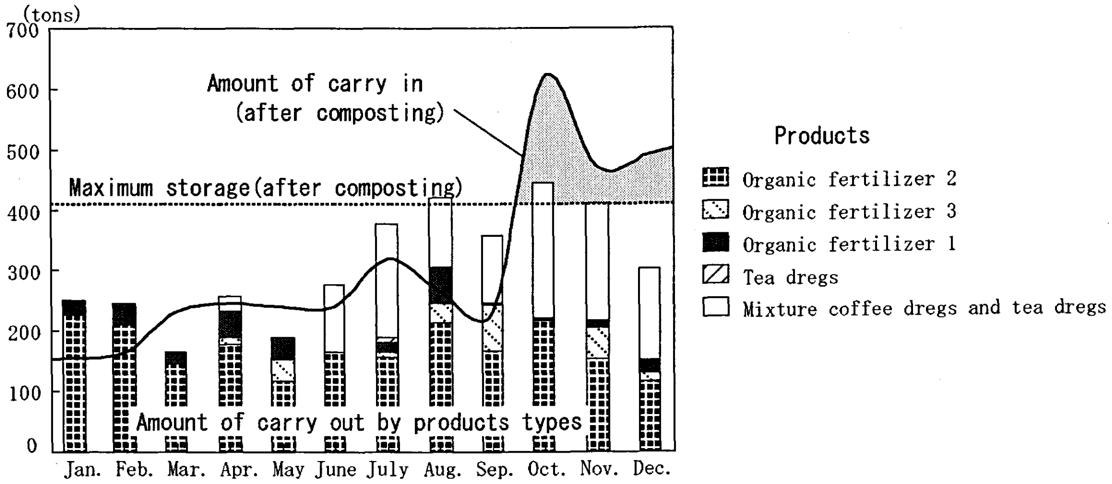


Figure 22 Balance of organic waste and storage limits in Corporation E, 2002

Note: Organic fertilizer corresponds Fig.21.
When carry in, it calculated as 700kg per $1m^3$ as of 2002.
After composting, it calculated as 429kg per $1m^3$.

(Source: Data from Corporation E)

Cities or to farmers who owned manure depots. The compost-producing corporation in Choshi City got acquainted with an introduction from waste collection and conveyance contractor 2, which is the corporation involved in the transported of waste from Corporation A to Corporation E. Waste contractor 2, which specializing in waste transport, previously had a rivalry with Corporation E over the transportation of the waste obtained from the soft drink manufacturer Corporation D. This rivalry changed to cooperation ever since Corporation E undertook the waste management of Corporation A. Corporation E established cooperation with another previous rival—the compost-producing corporation in Atsugi City—by undertaking its waste treatment by introduction. As a consequence, the compost-producing corporation adjusts the inventory with the cooperation of consumer, maintaining the demand and supply balance. A similar cooperation was established with waste contractor 1 as shown in Figure 14. Like Corporation E, waste contractor 1 is a corporation involved in the collection and treatment of organic waste. However, the waste that it could not treat was transported to a special trader of recycled products in Saitama Prefecture. However, unlike Corporation E, it is generally difficult for waste contractors to receive the cooperation of consumers who are not traders for inventory adjustment. Thus, connections between traders play an important role in the adjustment of supply and demand.

In the case of Corporation E, since the products were developed with the cooperation of farmers who owned manure depots, the untreated raw material stock was also adjusted with the cooperation of these farmers. As of 2002, the supply rate of untreated raw materials to these farmers was only 5.7%. However, the cooperation of the farmers is indispensable to inventory adjustment for the management of business at Corporation E.

When the amount of carry in exceeds that of carry out, there is a lack of space for composting. Hence, the compost raw material is often carried out as untreated waste. When the stock is adjusted, the untreated waste is received free. The disposal cost received from the waste generator is higher than the earnings from the sale of the commodity. Therefore, the gross revenue is unaffected despite the labor and transportation costs incurred in transporting the waste directly.

Consequently, inventory adjustment, which is the major obstacle in managing the business of Corporation E, has been overcome by a double adjustment with the cooperation of farmers and compost-producing corporations. Furthermore, the trade relations with these traders are developed with the help of introductions from ex-carrying origins and the contractors involved in the regulation of demand and supply. Therefore, it can be said that the network of waste contractors has a strong influence on the management of the business of waste treatment contractors.

CHAPTER 5

UTILIZATION OF ORGANIC WASTE IN VEGETABLE PRODUCTION IN THE METROPOLITAN SUBURB

1. Transition of Agricultural Production System in Miura Peninsula

1-1. Characteristics of Agriculture in Miura Peninsula

Discharge and the recycled of organic waste were examined thus far. In this chapter, it is analyzed that reproduced compost is utilized for vegetable farming in Miura Peninsula.

Miura Peninsula has developed for many years as a food supply area in the Keihin zone, which is the large consumption base. This region is composed of four cities that are Kamakura City, Zushi City, Yokosuka City, and Miura City and one town is Hayama Town. The annual mean temperature is 15.4 degrees, and precipitation is 1,530 millimeters[23] per year in the area. In addition, there is no frost region in Miura Peninsula. This region is a suitable area for crop cultivation by the climate that has clement and frequent rain in summer. The southern part of Yokosuka City and the Miura City zone are located in the south of the Takeyama mountain range where a fertile volcanic ash soil from the diluvial epoch extends. It is the main agricultural region as it accounts for 20.2% of total agricultural output of Kanagawa Prefecture in 2000 in Miura Peninsula.

In this regional region, a fertile soil with a clement climate is suitable for outdoor growing of watermelon, melon and squash as summer crops and of radish and cabbage winter crops. There are a lot of cultivation of cabbage and squash in the southern part of Yokosuka City and radish and watermelon in Miura City. Paddy rice is greatly decreasing, changing to upland crops though cultivation in the total area of these staple crops has not been changing for 40 years (Figure 23). The planted acreage of the outdoor melon and the squash increases since approximately 1975, instead of paddy rice's decreasing. Cabbage, radish, and watermelon have spread from the Meiji era (1864) to the beginning of the Showa era (1926) to this region. Although the planted acreage fluctuates, the yield tends to increase. The average arable land area per farm household is narrow with 80.2 acres[24)]. Annual utilization rate of arable land is, however, high with 220-250% by an intensive rotation of crops system as well as Japanese green leafy vegetables. Radish of gross output is the highest in Miura Peninsula. The unit cost of radish is low that differs from the quality of watermelon and melon to reflect the price easily. Therefore, the farmer prefers a large amount of cooperative shipment of radish. Radish is planted for 8,000-12,000 units per 10 acres in Miura Peninsula comparison with the national average with 5,000 units per 10 acres (Suzuki 2001). It has practiced highly intensive agriculture by super-crowded planting. Further, it has stored high technologies to furrow since the two-crop system period i.e. before 1930, started vegetable shipment. Thus, it has been devised to raise earnings by the

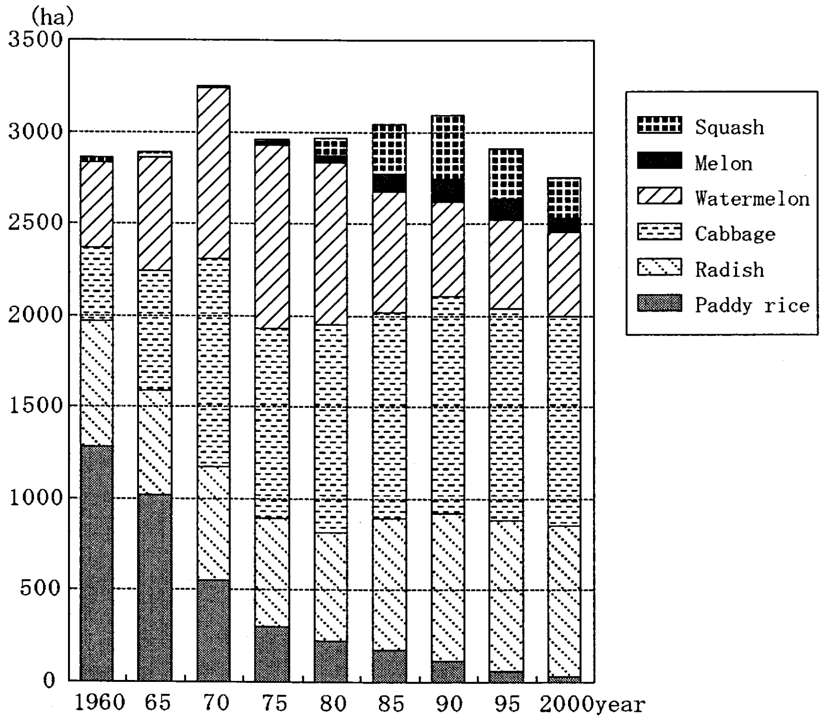


Figure 23 Cropping acreage of staple crops in Miura Peninsula, 1960-2000

(Source: World Census of Agriculture and Forestry and Data from Yokosuka Miura Area Agricultural Extention Service Center) small plot of land in Miura Peninsula.

Accordingly, the agricultural features of Miura Peninsula is effective use of the farmland where the price of land is high and the land is narrow by the plentiful yield cultivation by raising the utilization rate of arable land. This is different from the feature of suburban agriculture: small item and large-scale production. Miura Peninsula is defined in a suburban agricultural region with the functions that is a high utilization rate of arable land, intensive farming and supplies fresh crops to a large consumption base.

1-2. Transition of Cropping Systems and Organic Waste Collection

The preceding clause showed a high crop rotation and super-crowded planting in Miura Peninsula. It means the progress level of the soil poverty is higher than in general. Therefore, appropriate fertility management is requested. It has had a strong correlation with the development of crop production and the use of organism in Miura Peninsula, since vegetable cultivation has begun (Hashimoto et al. 1966; Saito et al. 1985; Namai et al. 1991). In this clause, it looks back on the change in the cropping system of agriculture in Miura Peninsula referring to existing literature. And, it is also examines the transition of organism collection that controls the agricultural productivity. The transition up to present of the collection sphere of organic waste in the Peninsula can be divided at three periods (Figure 24).

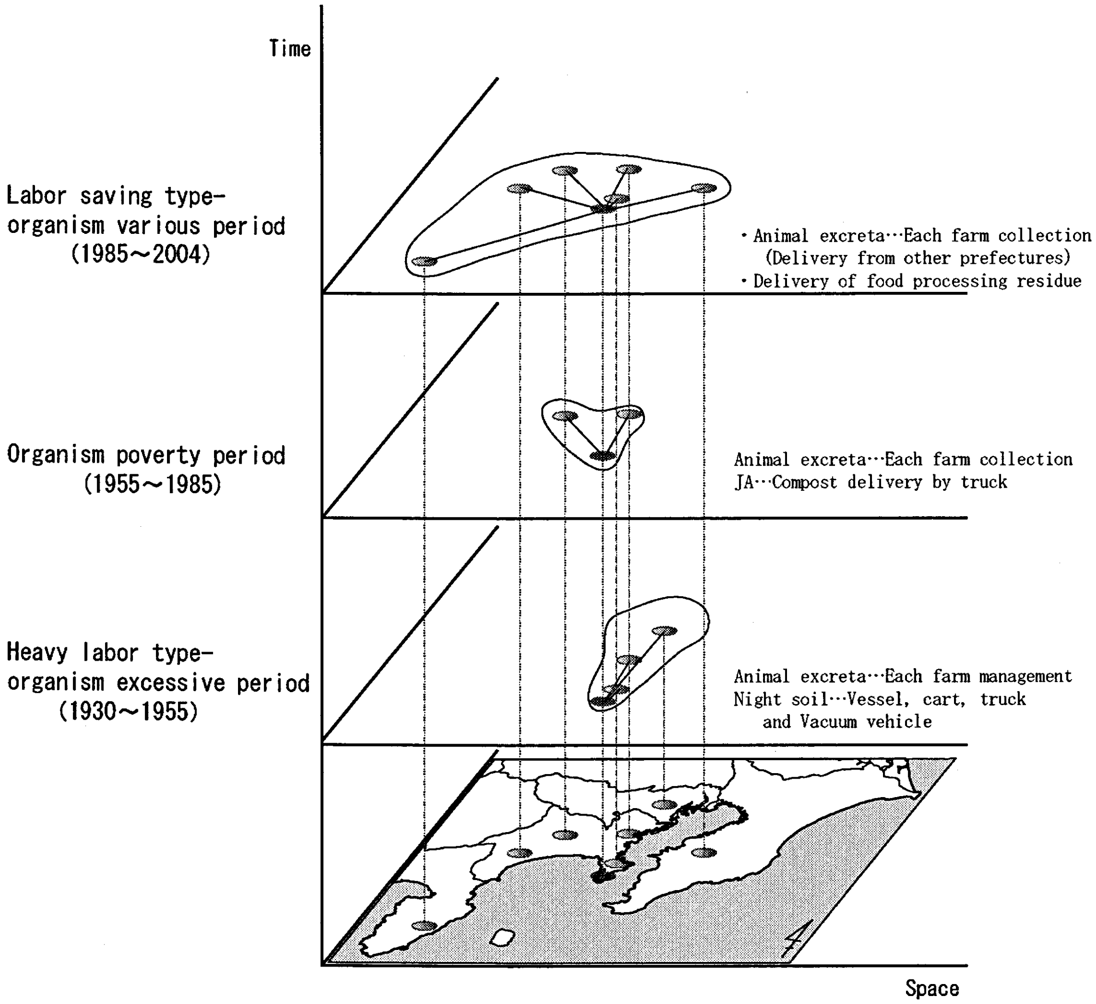


Figure 24 Transition of organic waste collection in Miura Peninsula,1930-2004

(Source: Hashimoto et al. (1966), Endo (1974), Saito et al. (1985), Namai et al. (1991), Matsuzaki and Tamura (2001), and data surveyed by author)

The first period is from 1930 to 1955. The vegetable shipment was started in 1930. In contrast, the time of 1955 is a main crop rotation that is five crops in two years. Radish and *onbaimo*[25] are introduced to the two-crop system that mixes with wheat and miscellaneous grain in this period. As a result, five crops in two years became a main cropping system. Since radish and *ombaimo* need a large amount of fertilizer, the volume of night soil controlled the crop's acreage (Hashimoto et al. 1966). Hashimoto et al. (1966) describe 'carrying of night soils was the main work of men at that time. They went out of their house at four o'clock in the morning. Then, it took time to take night soils for ten hours and work for two or three hours. In total, it was thirteen or fourteen hours of work for them.' It is clear that the radish cultivation was a big load of carrying the night soils. For the expansion of farm management size was difficult by above reason, there were many small farms (Sawada 1982). The city night soils were collected from Yokosuka City by cart or oxcart; its treatment became problematic. Further, the night soil carried into Miura by the night soil vessel that continued since 1877, was put in the barrel that was called *dambe* from Tokyo and Yokohama (Saito et al. 1985).

Night soil storage was constructed in the Kinda Bay and Ena Bay in the 1950s. It was carried from Yokohama by the vessel, and the farmer carried the city night soil to each of his fields. These night soils were bartered with farm products. That means the labor for carrying the night soils reduced. Moreover, it was assumed that utilization of fertilizer is good for crop cultivation. Therefore, an excessive fertilizer field existed at this time by the using night soil. Thus, the night soils from peripheral cities were used effectively in this period. Besides, plentiful carrying labor was needed for crop growing with lot of fertilizer. Accordingly, this period is defined as an organism excessive period with heavy labor.

The second period is from 1955 that is the end of five crops in two years to 1985, which is the prime time of three-crop system. It occurred the changing of dietary habits, replanting failure and the depression of the price by the competition with other production areas by 1960. As a result, the planted acreage of *Ombaimo* decreased, and the cabbage came to be grown as the substitution in spring (Namai et al. 1991). Furthermore, watermelon became a representative of summer crops in place of the upland rice, soybean and sweet potato, because the grafted tree technology had spread. Then, it shifted to the vegetable three-crop system with cabbage, watermelon, and radish after 1965.

Power tiller appeared around 1955, which expelled draft animal such as cattle and horse, and thus, the obtaining organic fertilizer became difficult. The agricultural cooperative promptly responded to it. They constructed the mixed fertilizer plant in 1957, and supplied the compost to farmers for six years. Moreover, Yokohama City came to transport the night soil directly to the manure pool by the vacuum car to the farmer's field in 1959. It led to the farmer's labor reduction. However, the night soil use in the city part was prohibited by the ordinance for sanitary reasons in 1967. As a consequence, the farmer requested an organic fertilizer from livestock farmers in the central Prefecture like Hiratsuka, Hatano, and Isehara Cities. On the other hand, the chemical fertilizer spread, and the use of the organic fertilizer with heavy labor came to be kept at a distance gradually[26)]. However, the soil diseases arose by excessive fertilizer use, and the planted acreage of the colewort vegetable increased. It led to decrease of the lime in the soil and accelerated the soil acidification (Nakajima 1986). Accordingly, the lack of a small amount of constituent and the virus disease of the radish occurred frequently in around 1960 (Okamoto 2002).

Soil analysis was begun in Miura City in the 1970s as a counter measure. The fixed-point observation has tried to prevent replant failure. Antagonistic plants[27)] with high effect of control were introduced in around 1975. According to Namai (1991), animal excreta of 73.9%[28)] per year was the necessary amount flowed in from suburbs in Miura City in 1975. In addition, an excessive and mistreatment of organic use caused trouble, such as damping off in the field. Therefore, individual compost was set up by the subsidy of the city in 1977. As a result, the use of drying compost that there is no adverse effect in the soil was promoted.

Furthermore, agricultural cooperatives bought the car only for the compost transportation in 1979 and compost was supplied to the farmer. And also, supply of the organic fertilizer began in 1982. Thus, the city and agricultural cooperatives positively used measures to supplement the lack of soil organisms. As mentioned above, the year from 1955 to 1985 is the period that the trial and error was repeated to the measures for organism poverty by changing the crop rotation and the soil deteriorated. In other words, this was the organism poverty period, which made efforts to obtain organism.

The third period is from 1985, the year that prevented the excessive use of chemical fertilizer until present. Basic cropping type is three-crops in a year as well as the second period. However, the cropping type became diversified in this period because wax gourd, melon and squash, using organic fertilizer, developed agricultural cooperatives. This is a result of the risk reduction of super-cropping because the price decreased and the disease harmed watermelon. Moreover, the soil improvement by the deep plowing of 40-50 centimeters with heavy machinery was carried out as replant failures and trouble measures. The replant failures have decreased gradually by cropping types diversification and the deep (Matsuzaki and Tamura 2001).

The farmer in this period made efforts to securing an organism for soils based on the experience of the forward period. Then, they worked on the use of various organisms. It is because the compost preferred by the every farm can be made as long as there is a raw material, since it set up individual compost depot at the organism poverty period. Therefore, various organisms, not only animal excreta from northern part or central prefecture, but also the green manure crops such as marigolds and the food processing residues began to be used. In this case, it tends to deliver the compost raw material, basically because it takes time for the utilized for compost. Further, animal manures are delivered from Izu Peninsula and Boso Peninsula because of decreasing livestock farmers in the region. There are farmers who go to these areas to get the manures. Accordingly, the range of the compost collection is extended every year. Thus, the organism tends to diversify as well as the diversification of the crop type. Furthermore, the collection of organism is extending, and the labor saving of the collection is advanced. Therefore, it can be said that this is the period of various organisms and of labor saving.

As mentioned above, Miura Peninsula has been influenced from socio-economic factors of the society in each period. It has developed as a leading production area of vegetable after it experienced change of cropping system and organism utilization in Miura Peninsula. That is, it can be said that the sustainable agriculture has been traditionally practiced in Miura Peninsula through it considered the maintenance of the soil productivity and high quality crops cultivation rather than the environmental stress.

2. Utilization of Organic Waste by the Farmers' Organization

2-1. Methods of Organic Waste Collection

There are three collection routes in Miura Peninsula except for individual negotiated transactions. They are composts of agricultural cooperatives, the livestock farmer's groups outside the prefecture, and the raw material of Corporation E (Table 4). Compost used is different, depending on the soil constituent and the quality. Compost that is the most used in Miura Peninsula is cattle manure with which is mixed sawdust (Okamoto 2002). Compost after the second fermentation needs less labor to use though it is expensive. Therefore, the farmers who have no own compost depot have the small-scale farm management or are aged farmers who prefer this. In contrast, farmers who have a compost depot can do the second fermentation on their farm. Hence, they willingly use a comparatively low-priced compost for the first fermentation finished. These farmers make compost that is mixed with the compost and the materials that are supplied from Corporation E except animal excreta. The coffee compost that E corporation supplies to Miura Peninsula is 4,800 tons per a year that is a little more than the amount of the supply of agricultural cooperatives.

The cattle manure that the agricultural cooperatives offer is about 10%, which is the annual fertilizing standard in Miura Peninsula of 40,000 tons (Nakajima 1986). The price of cattle manure from agricultural cooperatives

Table 4 Principal suppliers of organisms in Miura Peninsula, 2003

Supplier	Products	Conditions	Commercial cost (yen/ton)
Agricultural cooperatives	Organic fertilizer	First fermentation	20,000～25,000
Livestock farmer's group	Poultry manure	Second fermentation	10,000～15,000
Livestock farmer's group	Cattle manure	First fermentation	7,000～7,500
Agricultural cooperatives	Cattle manure	First fermentation	5,000
Other private corporation	Cattle manure	First fermentation	5,000
Corporation E	Organic fertilizer2,3	First fermentation	1,500

Note: Individual negotiated transaction is excluded.
Commercial cost includes transportation charge.
Numeral of organic fertilizer corresponds Fig.21.
Gray background shows the organism which uses frequency by farmers.

(Source: Surveyed by author)

including the transportation business is almost same as the case for the farmer who buys cattle manure privately. The amount of supply from agricultural cooperatives must be larger. However, it is limited to the field where going of the vehicle in and out is possible because it is transported by 10 tons car of the agricultural cooperatives compost. The farmer, who does the transportation labor of compost, prefer cheap dealings with livestock farmers individually. The farmer, who has no labor in transportation, deals with livestock farmer's group by paying about 2,000 yen per ton for carriage. In addition, there are farmers who grow the marigold and *avena strigosa* that is effective of the pest resistance instead of growing summer vegetables. It is plowed in for soil improvement for the physical, and the chemical soil property and the bacteria[29]. Thus, the farmer has flexibly selected the supply origin of the organism according to not only the soil conditions but also to the farm management scale and the form of every household. Haga (2000) describes that these tendencies are found in the farmer generally as their features.

2-2. Regional Development of the Farmers' Organization

There is the Recycling Union that has supplied organic matters, monopolizing it from Corporation E in Miura Peninsula. The Recycling Union is a non-profit farmers' organization. It was established aiming at the promotion of the organism utilization and its securing in 1989. The reason was a spread of the soil disease that had become a problem at that time. It reached 255 persons as of 2003 even though members when starting were 75 farmers in Yokosuka and Miura Cities. It contains 11.4% of commercial farms and 25.4% of full-time farms in Miura Peninsula. The member is distributed in the region that is overall adjacent to the big market area (Figure 25). There are especially a lot of members in the southern part of Yokosuka and Miura Cities where the farmland is distributed and the time for dealing with them is early. At first, Miura City JA was having dealings with Corporation E through the waste switching system of the prefecture. Afterwards, Corporation E got acquainted with a regional leader, who was related to the inauguration of the Recycling Union by the staff of Miura City JA. It arrived at a present number of members because each district farmer leader's understanding had been obtained by development of use of the food industries residue between the farmer leader, Corporation E and a human network of Miura City JA staff.

The Region from southern part of Yokosuka City to Miura City is divided into seven in the Recycling Union. There is a director who arranges the order in each district. Each farmer places orders to the director in his district by telephone. The director contacts Corporation E by fax as soon as it receives an order. Then, Corporation E carries compost directly to the field or compost depot of the farmer who has placed and order. As a result, the farmer is able to obtain the compost or raw materials of a necessary amount at a low price when

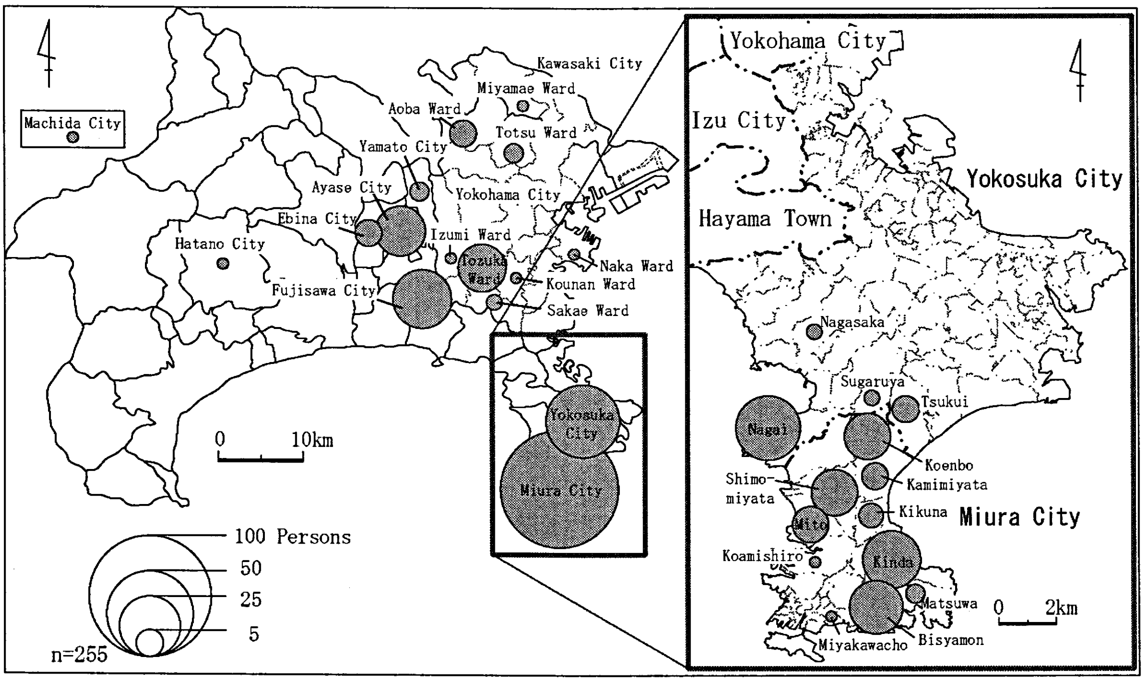


Figure 25 Distribution of farms participating the Recycling Union, 2003

(Source: Data from Corporation E)

it is necessary. There is neither a collection of the fee[30] nor meetings at all of the Recycling Union. However, the farmer exchanges information through the network of the union. Moreover, farmers make an effort to collect information of soil making by participation in the workshop or other production organizations individually. The general meeting with Corporation E is held only twice a year with the director. However, Corporation E collects information of farmer's conditions through the compost carrying business, and responds to their complaint and opinion flexibly.

3. The Second Treatment Process and Its Relation to Farm Management

There are summer and winter crops in the staple crops grown in Miura Peninsula. Many organisms are needed for winter crops like root vegetables and leaf vegetables than fruit vegetables in summer cropping. Basal fertilizer is used 1 ton per 10 acres before summer vegetable seeding and less than 2 tons per 10 acres before winter vegetable seeding[31]. Accordingly, organic waste from Corporation E to the Recycling Union is the most from August to September (Figure 26). Organic waste is applied for spring cabbage from November to December and for the compost making for cropping from March to May. Because the farmers who have no compost depot avoid the purchase of the organism in June in the rainy season, the supply amount from Corporation E is

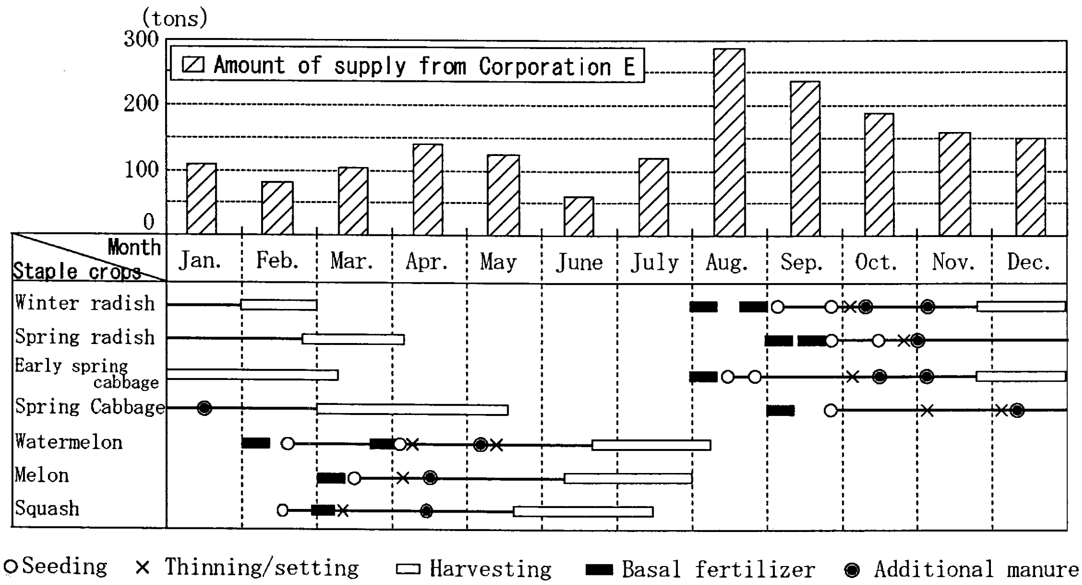


Figure 26 Supply and demand of organic compost in Miura Peninsula, 2002

(Source: Data from Corporation E and Kanagawa Prefecture) little. The supplied organism is chiefly used as basal fertilizer, and the chemical fertilizer is used for the additional fertilizer[32]. The use of compost is different, depending on the kind of crops cultivated and the soil condition, and there is bias in the demand season.

There are many farmers who run a full-time farm household in the Recycling Union. Most of them manage arable land that exceeds the average size of Miura Peninsula greatly (Table 5). The farmer who owns a compost depot has a farmland of more than 1.5 hectares. They chiefly grow radish and cabbage with a large amount of compost application.

The farmer ferments the second compost supplied by Corporation E. The fermentation period for the farmer to whom the application amount for the field has been sufficient by supply of Corporation E, is long. Moreover, there is no mixture, excluding rice bran, as a fermentation accelerant. These farmers use compost after fermentation enough because its size of management arable land is large. On the other hand, the fermentation period is short for the farmer from whom the amount of the supply by Corporation E doesn't reach a necessary amount. The trouble will tend to go out to crops when immature compost is applied to the field. Therefore, these farmers use solar energy for drying[33] before the field application of compost. Besides, the farmer of this type is making high-quality and original compost. The feature is to promote the adjustment of the amount of moisture and the microbial degradation of the

Table 5 Farm management and compost use of representative farmers in the Recycling Union, 2003

Farm number	Full time/ part time	Management arable land (acre)		Utilization rate of arable land	Staple crop (acre)		Compost depot	Antagonistic plant (acre)
		Upland field	Others		Summer	Winter		
1	Full	210	40	2	Melon 100	Radish 200, Cabbage 100	Have	100
2	Full	200		2	-	Radish 200, Cabbage 100	Have	60
3	Full	180		2.5	Melon 50	Cabbage 130, Broccoli 85	Have	60
4	Full	160		2.35	Wax gourd 50	Cabbage 140, Radish 105	Have	-
5	Full	125	25	2	Sweet corn 25, Watermelon 20	Radish 70	No	-
6	Full	100		2	Squash 30 , Watermelon 20	Radish 75, Cabbage 55	No	-

Fermentation period	Compound when the second fermentation				
	Nothing	Rice bran	Cattle manure	Food residue	Others
3-6 months		3 $\boxed{4}$ 5	3 6	3	3 5
6-12 months	$\boxed{2}$	$\boxed{1}$			

1~6 Farm number

$\boxed{}$ Supply from Corporation E $\geq$ Suitable amount of organism application

Note: This is the case of supposing that the amount of the standard organism is applied to all upland fields of each farm.

(Source: Surveyed by author)

amount of moisture by mixing various organisms. The compost of Corporation E is inexpensive compared to other compost. However, in Miura where the annual utilization rate of arable land is high, it costs more and takes time to make compost by covering all of the cultivation area. For this reason, compost application for a two-crop system is a limitation for the farmer. It is found that farm management greatly influences not only the way of compost collection, but also process of the second fermentation.

4. Changing Selections of Raw Material for Compost

This section considers the select condition of raw material to make compost through the dealings change of the Recycling Union and Corporation E.

It was an important issue in agriculture to secure compost for soil improvement in Miura Peninsula when farmer's leader and Corporation E had met (Figure 27). As for the other E corporation, the business management was faced by a crisis because of decreasing customers. Then, Corporation E got the cooperation of the Miura City JA staff and the local farmer's leader. Afterwards, the organic waste system was developed, so that the farmers could use it easily. The use method and conditions of organic waste were clarified after two years for it to suit most use the mixture with cattle manures and proper fermentation period for all supplementary materials (Matsuzaki and Tamura 2001).

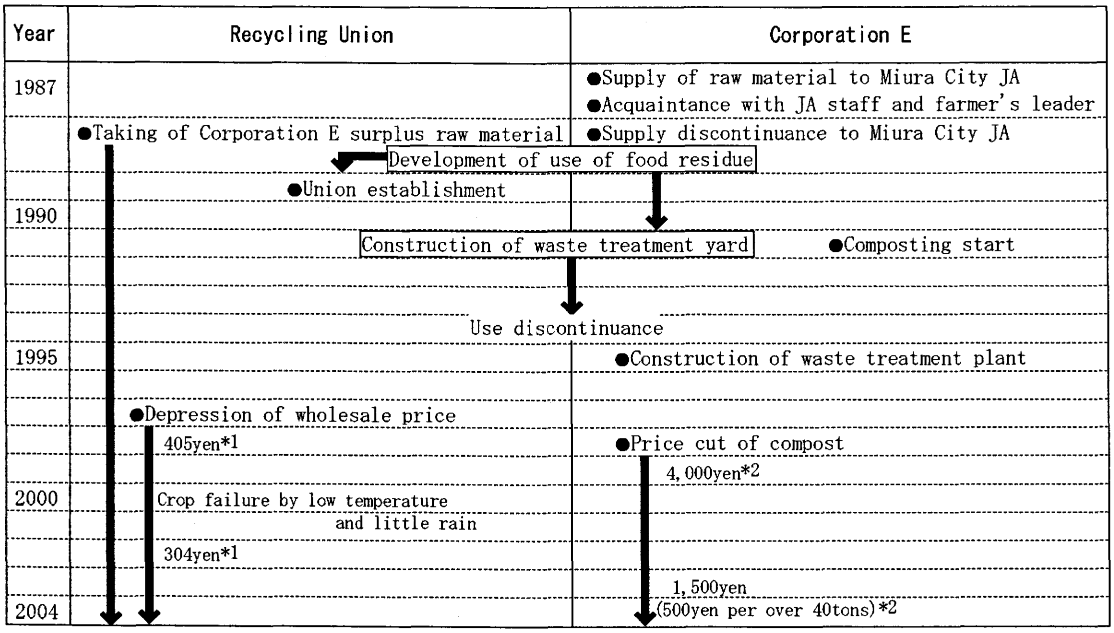


Figure 27 Business relationship between the Recycling Union and Corporation E

Note: *1: Total price of Tokyo Metropolis wholesale price per kg of staple crops (cabbage, radish and watermelon).
*2: Compost price includes transportation charge per ton.

(Source: Data from Corporation E, and statistics of the Ministry of Agriculture, Forestry and Fisheries of Japan)

The problem after development of the use method of food residues was to increase the users. 78 users could be gathered since the staff of Miura City JA made an effort to recommend for a leader in each district to use it. The farmer was able to secure the organism in a stable manner by this union inauguration, and Corporation E was able to supply customers the compost of a constant amount. In Miura Peninsula, there are only few livestock farms. Farmers had gone to take manures to livestock farms in Atsugi or Fujisawa before dealings with Corporation E. It costed carriage, and took time for the transportation. Also, there was the limitation of burden. Thus, the farmer preferred the raw material of Corporation E that is delivered to the field at any time to livestock farms in the central Prefecture. Corporation E analyzes the products regularly to obtain the confidence of the farmers.

During the developing of use of the compost raw material, Corporation E used the barn of a farmer's leader, who managed livestock farming, as a temporary storage place. However, Corporation E needed the treatment area and the storage because the amount for transported and the raw material demanded by the farmer after treatment, increased. Then, the Recycling Union and Corporation E invested jointly in 1991, and the compost treatment area was constructed in Ayase City. Corporation E had to restore land to the landowners and leaseholders in several years. Therefore, Corporation E launched out into the construction of its own treatment plant. Even though

Corporation E stores raw materials in their plant, the volunteer of the union member who has a compost depot is still accepting the compost raw material at no cost up to the month when the amount of carrying to Corporation E is large. Furthermore, Corporation E tries to make a quick turnover of products by supplying it to the farmer who orders over 40 tons or more over at a time for 500 yen per ton.

On the other hand, the market wholesale price of the staple crop of Miura Peninsula fell after 1995. The market wholesale price keeps falling on summer cropping every year after the peak price in 1998. The strategy that the farmer took under such a situation is to reduce the production cost. Corporation E has greatly lowered the products price by the request of the farmers whose management was in crisis when the wholesale price of the vegetables was low. Thus, the Recycling Union and Corporation E has made the cooperative relationship supports management for each other.

Farmers had requested the animal excreta from the livestock farmers of central prefecture before the union started even though it was expensive. It can be said that the farmer's motive to select products of Corporation E is the great confidence in the products and sense of security by the recommendation of staff of Miura City JA. The foundation of shift to products of Corporation E is built up to the product's development by collaboration and cooperator's human networks. And also, the principal reason to have used the products of

Corporation E continuously by the farmers is a flexible delivery system. Carrying of compost raw material is heavy labor for the farmers who grow three-crops in a year by only family labor. It costs the express fee to go to take the animal excreta. Moreover, it is not possible to carry it out at one time in large quantities because there are weight limits. Besides, the advantage in management is little, because it is work spread over a day. The price goes up when orders are placed to the livestock farmer who delivers it. Securing the necessary amount of organism without taking much time and at a low price is favorable to their farm management. Products of Corporation E move attractively to the farmers because Corporation E delivers them the necessary amount directly to the field when they are needed. Consequently, it can be said that the reasons to have selected the products of Corporation E continuously by the farmers is a business management's posture flexibility in Corporation E and confidence in it from the farmers.

CHAPTER 6

ESTABLISHMENT OF THE ORGANIC WASTE UTILIZATION SYSTEMS

1. Interrelation between Actors

1.1 Formation of Distribution Structure by Industrial Waste Contractors

In this chapter, the basis of organic waste utilization systems in Tokyo Metropolitan Area is considered through analysis of interrelation among actors, their priority of business relationships, and the spatial structure.

First, the distribution structure of organic waste is shown in Figure 28. Before waste generators establish a new production line, there is a business promotion from waste collection and conveyance contractors. The waste generators often contract several collectors to reduce disposal cost when negotiating. Waste collection and conveyance contractors collect the information on manufacturers' production plans beforehand. Business competition among waste collectors is started with the sales promotion. The waste collectors have agreements with recycling contractors through their own network before the business promotion. The WDPC law requires the waste generators to contract with both waste collection and conveyance contractors and recycling contractors who have permission from administration. Togawa and Matsunaga (1997) report, however, that in reality waste generators directly

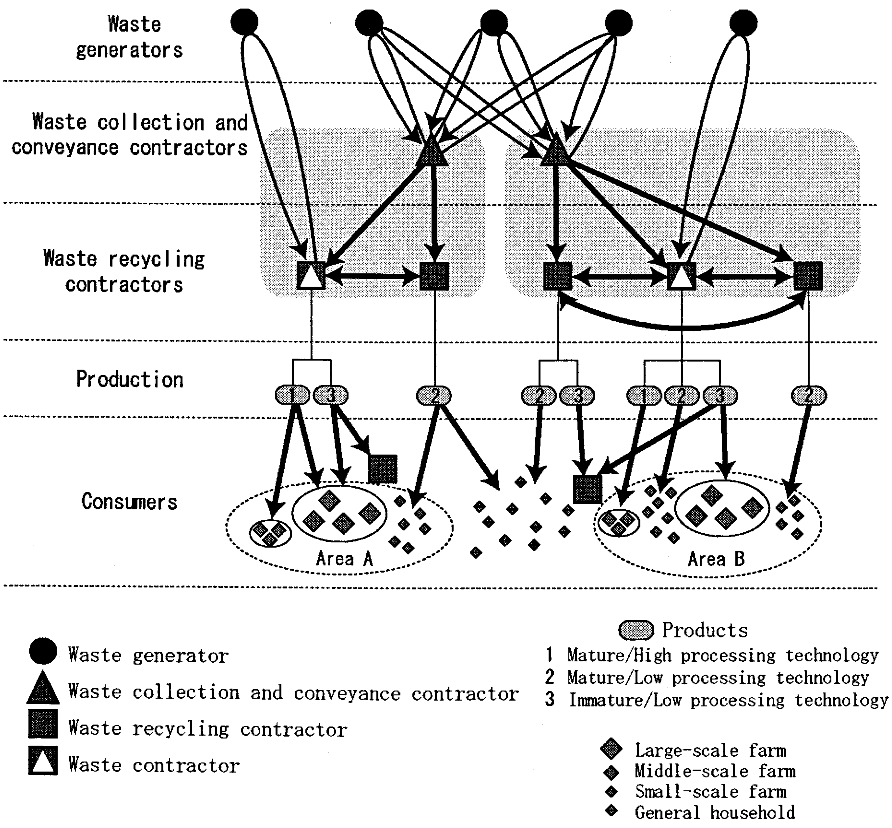


Figure 28 Structure of organic waste distribution in Tokyo Metropolitan Area

contract only with waste collection and conveyance contractors, and there is no contact with the waste-recycling contractors. Therefore, the fact that the waste collectors have agreement with waste-recycling contractors before they contract with waste generators means that they are advantageous in sales. In many cases, there are contract relations between the waste collector and waste-recycling contractors for a long time. There are some waste-recycling contractors who used to collect and convey the waste with waste recycling. In this case, the waste-recycling contractors were the rivals of the waste collection businesses. Accordingly, there is little possibility that waste supply destination overlaps with waste-recycling contractors who are related to other waste collection companies. Thus, waste collection and conveyance contractors have restrained waste generators by using their own waste network. In other words, it can be said that an entry of new businesses is not done easily because specific waste collection contractors control the waste distribution.

Second, waste-recycling contractors combine the organic waste from waste collection and conveyance contractors and the organic waste that they collect on their own, and makes the products to which the constituent is steady at the commercialization stage. In the case when the excess or shortage of compost's constituent and quantity occurred, organic wastes are exchanged between the waste-recycling contractors. This exchange is conducted between the waste-recycling contractors who are affiliated with the same collection and conveyance contractors. According to the interview in this study, it is found that there are a lot of cases where the waste-recycling contractors that produce compost were once livestock farmers or currently manage livestock farming. Therefore, the organic waste that each company has is exchanged besides the conveyed waste.

In addition, recycling contractors have a problem of changes of supply and demand balance in their business management. Businesses (given by α-β) can manage their inventory products until the marginal value (κ) reaches storage quantity (Figure 29). However, when the marginal value is exceeded, the stock stays. In this study, the farmer has covered the partial role of inventory adjustment. This is limited to a case when waste-recycling contractors and farmers have a trusting and understanding relationship. The role of inventory adjustment is usually covered by waste-recycling contractors. Thus, waste-recycling contractors manage the balance adjustment of organic waste with affiliated recycling contractors not only amount of the storage but also amount of the inventory. Accordingly, it was found that the network of waste collection and conveyance contractors is used effectively to produce good quality products and to stabilize the business management of waste-recycling contractors in the regeneration treatment stage.

Third, the composted process products are roughly divided into three types. The first type of product requires high processing technology because the

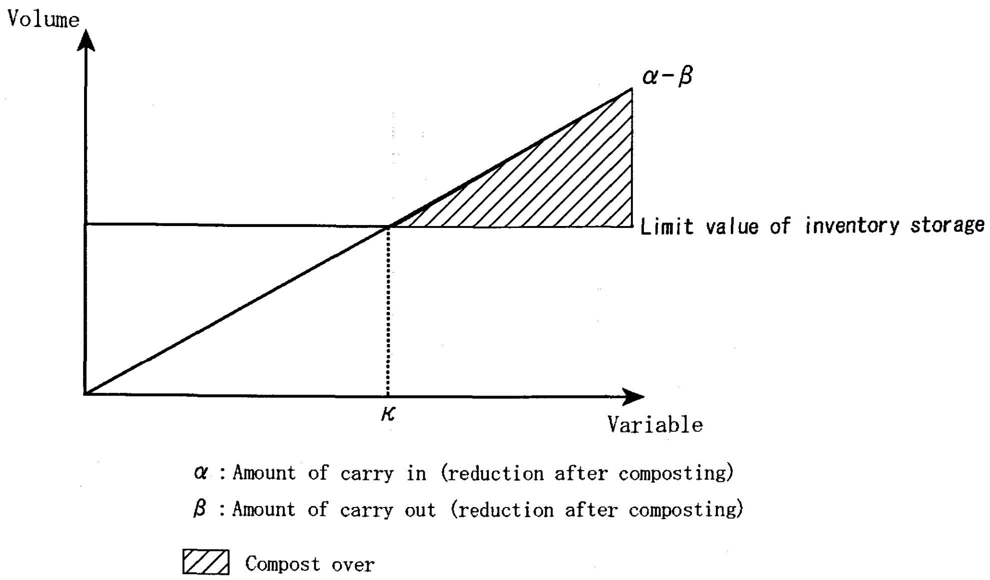


Figure 29 Limit of inventory storage

raw material has high moisture content and includes the material that is difficult to process. The waste-recycling contractors are limited because the disposal cost of this organic waste is higher than others. The products tend to be dealt with by the recycling contractors which also manage waste collection businesses, as in the case study of Corporation E. The second type of product is good quality compost in which the mixed waste is abundant and near full ripeness, which does not require skilled processing technology. High-quality compost is mass-produced by most of recycling contractors. The third type of product is the mixed compost, which uses simple raw material, and its ripeness level is low. It is possible to make such compost relatively easy without spending time for processing. The recycling contractors who also manage waste collection business in order to improve the turnover ratio of the commodity often manufacture this. Although various other products can be made, these three types of products are principal commodities of the waste-recycling contractors.

Fourth, the demand for the product changes by the size of the farm, cropping types, and farmers' ownership of compost depots (Haga 2000). For instance, the farmer who grows a certain specific crop uses the first type of product that require special raw material. The farmer who has no compost depot or the general household for home garden demands the second type of product, good quality compost with full ripeness. The third type of product needs second fermentation for mistreatment. Hence, the customers of such products are large-scale farms or affiliated waste-recycling contractors. Thus, the types of products made divide the types of consumers. Affiliated waste-recycling contractors exchange the information among them in order not to overlap the characteristics of the customer or distribution channel. Each waste recycling contractor has its own territory. The development of distribution channels is conducted through sales promotion and introduction by waste generation and collection companies, corresponding to each product.

In summary, there are two findings: (1) there are territories and affiliations of organic waste distribution by the network of waste collection and recycling contractors; (2) there are characteristics of demands in each type of organic waste products. Waste collection and conveyance contractors manage upper stream division[34)] (production) and midstream division (processing), and waste-recycling contractors manage downstream division (consumption) in the organic waste distribution of Tokyo Metropolitan Area. Waste collection and conveyance contractors and waste-recycling contractors connect with organic waste generators and the farmers through this structure. In short, the function of industrial waste contractors is the basis of the organic waste utilization systems in distribution of organic waste.

Since the WDPC Law was revised, appropriate disposal of waste is required. However, neither the method of dealing nor its information has been disclosed. Such lack of clarity of organic waste distribution is a general characteristic of waste distribution (Togawa and Matsunaga 1997). It can be said that the actor's relation and the structure of waste distribution on organic waste are a special mechanism formed in cases when industrial waste contractors are to join the business.

1-2. Interrelation between Actors and Their Business Priorities

The motive and time that actors came to be involved in organic waste are compared (Table 6). Environmental problems began to be considered and started to be involved in organic waste first by the consumers, followed by waste collection and recycling contractors, and waste generators. The Recycling Union has practiced the use of organic waste from the earliest time in my case study after the soil degradation. Internal factors such as their need to secure organisms after the soil degradation have greatly influenced the activity of the Recycling Union. It took about 30 years from the occurrence of the problem for the Recycling Union to start their activity after problems occurred. Problems such as decrease of soil fertility because of replant failure, continuous application of chemical fertilizer, and the resulting the soil degradation have led to the activity to start securing organisms. Thus, internal changes take place comparatively in the long term because it takes time to consider the specifics of the problem or to find solutions. The tendency to request the

Table 6 History of actor's relation to organic waste

Year	Waste generator (Corporation A)	Waste contractor (Corporation E)	Consumer (Recycling Union)	Social background
1960			Frequent occurrence of soil disease	Spread of chemical fertilizer
		Corporation establishment	Night soil use prohibition Spread of cattle manure use	
1970	Plant establishment		Soil diagnosis start	
			Introduction of green manure crops Introduction of compost depot	
1980	Coffee production start	Waste disposal permission acquisition		
		Dealings request of Corporation D Organic waste business start Transactions start year	Transactions start year Recycling Union establishment	Coffee demand expansion Rise of concern to environment Tea demand expansion
1990	Tea production start	Composting start		Earth summit
2000	Waste treatment in own corporation Acquiring of ISO 14001 certification Acquiring of HACCP certification Transactions start year	Transactions start year		
2004	Make new production line			

organism from the occurrence of the soil disease like the Recycling Union was seen throughout the country (Kada and Nishio 1999). Similarly they used organic waste at a comparatively early stage. However, it was not until 1992 when the guideline of sustainable agriculture that uses organic waste was defined by the government (Table 7). Therefore, there are some regions where they came to use organic waste actively after the law was enforced. In this case, the relation to organic waste is influenced by an external factor, the law.

Next, Corporation E has dealt industrial waste such as scraps and plastics excluding organic waste after the corporation was established. Their entry into organic waste began at the request of the plant that had long business transactions. It can be said that the involvement of Corporation E in organic waste was influenced and begun by the external factor. Generally, it is easy for business to be controlled by the external factor because the new entry to waste recycling businesses is performed with an introduction from a waste collection and conveyance contractors or a related establishments.

Corporation A has discharged organic waste and sludge since the middle of 1980s. The sludge was dumped at sea, and plant residue was not managed in the beginning. However, the corporation A soon began to demonstrate active reactions to the environment such as establishing their own waste treatment plant in 1999 and acquiring ISO14001 in 2001. Moreover, the laws related to the waste control and recycling promotion were enforced after

Table 7 Laws and certification systems related to each actor

Year	Official denomination (Abbreviation)	Object actor	Restricted matter
1971	Waste Disposal and Public Cleansing Law	Waste generator Waste generator	Control of waste discharge, Proper treatment Permission of business and registration of treatment facilities
1991	Part revision of Waste Disposal and Public Cleansing Law	Waste generator	Update of permission Division of waste collection business and waste disposal business Shift to permission system of treatment facilities
	Law for the Promotion of Utilities of Recycled Resources	Waste generator	Manufacturing that considers recycling Use of recycled resource in manufacturing process
1992	New Direction of Food, Agriculture, and Agricultural Policy	Consumer(farmer)	Shift to sustainable agriculture that considers reduction of environmental stress
1996	Coming into effect of environmental management system standard (ISO14001)	Waste generator	To decrease and improve the environmental stress
1997	Part revision of Waste Disposal and Public Cleansing Law	Waste generator	The manifest system is applied to all wastes.
1999	Basic Law on Food, Agriculture and Rural Areas	Consumer(farmer)	Sustainable development of agriculture and promotion of agricultural village Securing of stable food supply, Multiple functions
2000	Law for the Promotion of Effective Utilities of Resources	Waste generator	Reinforcement of recycling Control of waste generation
	Law Concerning the Promotion of Recycling Food Cyclical Resources (Food Recycling Law)	Waste generator	20% reduction in amount of discharge untill 2006 Obligation of recycling
	Revision of Offensive Odor Control Law	Waste generator	Restriction of specific malodorous substance
	Part revision of Fertilizer Regulation Law	Waste generator	Propriety of descriptive label Obligation of attached guarantee certification of sludge fertilizer
2001	Basic Law for Establishing the Recycling-based Society	Waste generator Waste generator Consumer(farmer)	Construction of sustainable society Control of waste discharge, Recycling of discharged waste Proper disposal of discharged waste
	Part revision of Waste Disposal and Public Cleansing Law	Waste generator Waste generator	Reinforcement of responsibility for waste generator Promotion of recycling Prevention of illegal dumping Prohibition of incineration of waste
2002	Law for Promoting the Introduction of Sustainable Agricultural Production Practices	Consumer(farmer)	Display system of agricultural products Production promotion of organic farm products

1995 by rising public concern to the environment after the Earth Summit (Table 7). The government issued an environmental certification of ISO14001 in 1996. Since then, each corporation began to create its own environmental policy by introducing the ISO international standard. Corporation A also began to operate its own environmental reaction at the same time period. In addition, the waste generators that have not implemented the ISO international standard were also restricted to disposing and processing their waste by the WDPC Law, which was enforced in 2001. The amount of waste recycling in food industries increased rapidly soon after the WDPC Law was enforced (Ushikubo 2003). Hence, the decision-making behavior that considered organic waste management in Corporation A arose from the social background, laws, and market competitions. In the case of Corporation A, external pressures to manage organic waste forced them to be committed to the environment in a short time.

The business relationship between the three actors is integrated on Table 8. Next, I analyze each actor's priority in the business relationship through the findings of the characteristics and disadvantages in their management. First, the waste generators can appeal to the consumer as a corporation that practices an internationally standardized environmental certification by introduction of ISO14001. On the other hand, disposal cost has inevitably increased because of controlling waste management. Even though

Table 8 Relationship between actors on organic waste and products

	Object	Advantage	Disadvantage
Waste generator	Products consumer	Image improvement	Hardly reflect on the buying intention
	Waste contractor	Consignment of waste management	Increase of recycling cost
Waste contractor	Waste generator	Waste transportation and recycling charge Obtaining of compost raw material	Change of quality and quantity of waste
	Organic waste consumer	Commercial cost	Change of demand and amount
Consumer	Waste contractor	Labor saving of transportation Obtaining of good compost inexpensively	—
	food consumer	Supply of good quality farm products Image improvement	—

the waste generators expects an increase of buying motivation by introducing the ISO, the ISO introduction became generalized within society and the direct feedback from the consumer is little. Thus, the reaction to environmental problems by the waste generators was urged by the rise of the concern about the environment and by the legislative pressure. The need of waste management even if the cost performance is low is putting pressure on the business in a short time period.

Second, industrial waste contractors can receive a comparatively high carriage and disposal fee from the waste generators. In addition, industrial waste contractors can also make a profit by making compost and then selling it as products. However, there are disadvantages for these companies. For example, the collected organic waste differs by the collection origins, and the amount of collected waste also changes each day. In the relation to the organic waste consumers, there is a quantitative fluctuation of carry out demand depending on season. Consequently, the business management needs to be able to adjust the amount of waste supply and demand and that is a big problem for the waste contractors. In the research of the compost center, Haga (2000) pointed out that a problem of the compost distribution is not storing the inventory of high seasonal compost.

Third, organic waste consumers can obtain a good qualified organism for the soil preparation from industrial waste contractors at a low price. In addition, organic waste consumers can reduce the carrying labor of the organic waste because the organism is basically delivered to the place where consumers want it. Furthermore, organic waste consumers can supply the high-quality farm products to their food consumers by applying compost. It can also to improve the image of the production area where sustainable agriculture is being practiced. Therefore, organic waste consumers are actors with a lot of advantages in relations between the industrial waste contractors and food consumers in their businesses.

As a result, it is obvious that the priority between actors in the organic waste business is the order of the organic waste consumers, industrial waste contractors, and waste generators. In business contracts between the waste generators and industrial waste contractors, the latter makes the price decision. On the other hand, there is no contract relation in deals of industrial waste contractors and consumers. Therefore, consumers have a right to select the supplier on their own for the compost product. The organic waste consumers were in a weaker position in the deals when the quantity of the organism was insufficient. However, the position of the organic waste consumers has changed to the higher level gradually in business relations by the market mechanism of supply and demand since the food manufacturing industries and others have entered into making compost. In short, it can be said that a social background made the position of the organic consumers dominant.

The actual conditions of organic waste distribution were added to the analysis of the interrelation between actors in business relations (Figure 30). Each actor deals goods and services. It can be said that the food product consumers are indirectly related to the use of organic waste because the industrial waste contractors and the organic waste consumers supply the food products to the food products consumer. It is concluded that the organic waste utilization systems consist of two mechanisms of two actors' direct business relationship. In the following, the basis of relation between two actors is examined.

There are four bases between waste generators and industrial waste contractors on their business relationships. It is assumed that both believe that discharged waste should be recycled. This philosophy is a result of the advantage of the waste disposal in waste generators, and high waste treatment agency fees by industrial waste contractors. Moreover, a network among the industrial waste contractors contributes to tie these two actors and support their relationships.

The good quality of products and services as well as quick reactions by industrial waste contractors basically maintain the relation between organic industrial waste contractors and organic waste consumers. Moreover, securing the inventory storage of industrial waste contractors offered by the cooperation of other waste contractors and the farmers is an essential in keeping the

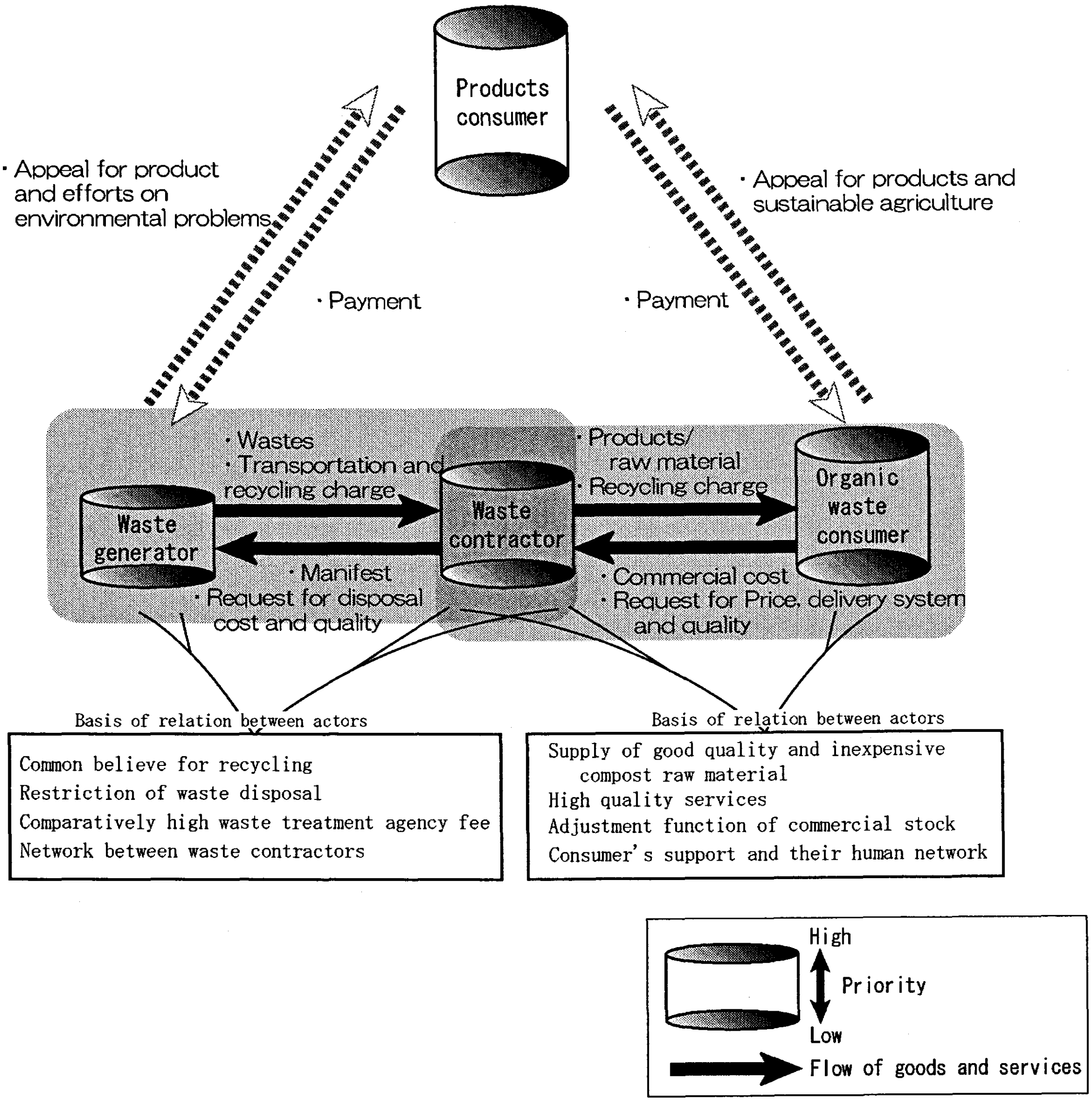


Figure 30 Business interrelation between actors on organic waste

business relation. In addition, the network of regional leaders and the cooperators who collect organic waste consumers' information and opinions also contributes to maintain communication between two actors and expand the demand.

The bases of each relation are pointed out from the general characteristics of each actor and their business relationship. Therefore, the same thing applies to the following cases when the waste generators are food-manufacturing industries, the industrial waste contractors are private corporations, and organic waste consumers are farmers. The organic waste generators and consumers do not have direct relation to organic waste. Deals of industrial waste disposal are different from usual market deals. When waste is collected, the invoice, called a "manifest," is issued. In other words, the contract becomes effective when the document that shows the treatment method and the site of treatment is handed to the waste generators and the prepayment to the waste conveyance and treatment agency is made. The waste generators do not know where the organic waste is being consumed after the waste is recycled. Therefore, industrial waste contractors play a critical role in connecting organic waste generators and consumers in organic waste utilization systems. Hence, it is difficult for industrial waste contractors to operate the function of the system without any troubles.

2. Spatial Structure of Organic Waste Utilization

Figure 31 indicates the spatial structure of organic waste utilization in Tokyo Metropolitan Area. Spatial connectivity of supply and demand of organic waste existed between the location of industry that discharged various organic wastes and the agricultural production area that needed maintenance of soil fertility for intensive farming.

Corporation A, a soft drink manufacturer in this case study, is located in the vicinity of a highway that has efficient shipping functions. Three other soft drink manufacturers that deal with Corporation E are also located along the highway. Additionally, as I pointed out in Chapter 2, establishments that discharge organic waste are generally located in a suburb approximately 50 kilometers from central Tokyo, the coastal area, and along the highway. Since the transportation condition was improved in recent years, the industrial location tends to value the accessibility to the market rather than the site where raw material is produced (Yanai 2002). Hence, the plant is agglomerated to certain industrial estates along the highway and the main road toward the central city of Tokyo.

The Recycling Union in Miura Peninsula, the organic waste consumer group, is located in Tokyo Metropolitan suburb. Since the accessibility to the large market is high, they practiced high-yielding agricultural production by intensive farming and high utilization rate of arable land. The farmer needed

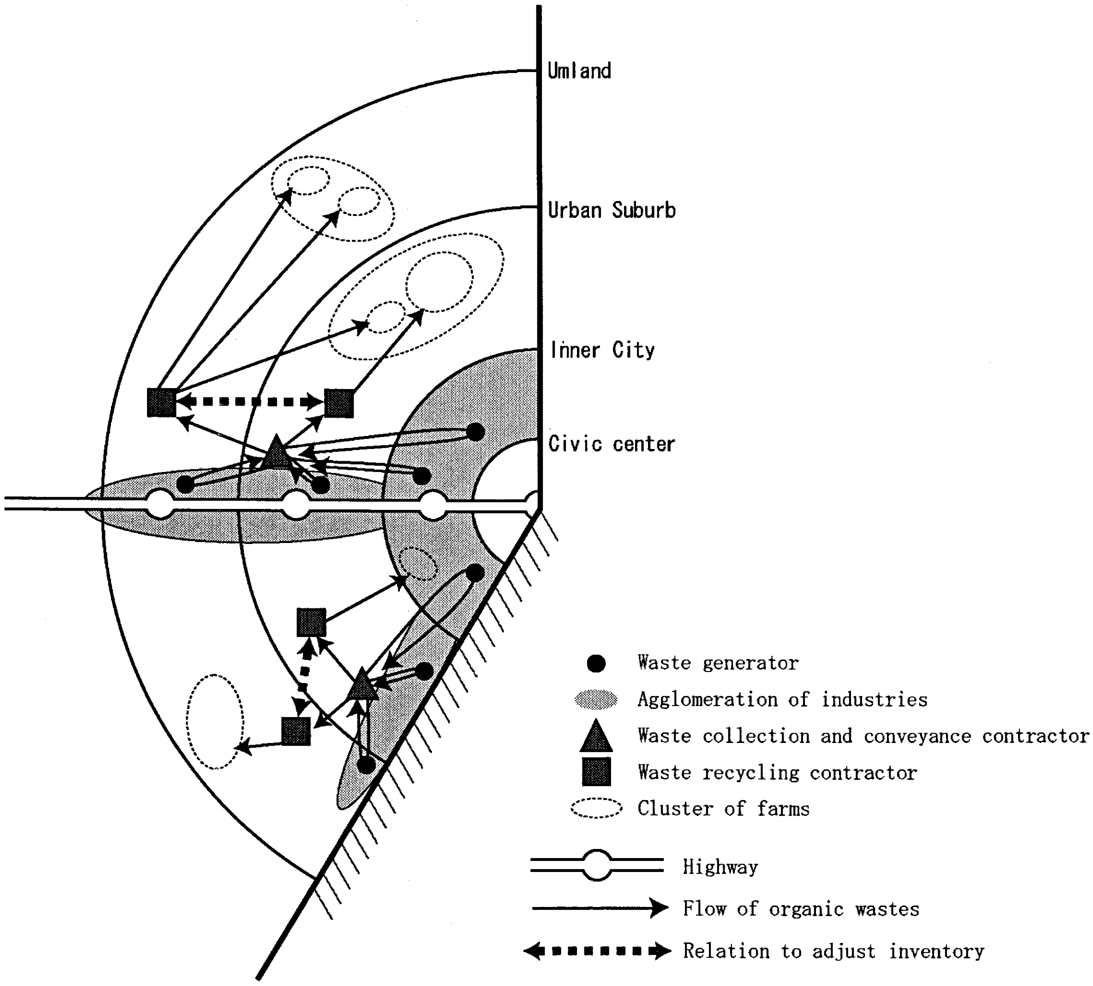


Figure 31 Spatial structure of organic waste utilization in Tokyo Metropolitan Area

the maintenance of soil fertility by organism to stabilize the yield. In addition, the majority of the farmers grow crops that consume many organisms such as root vegetables and leaf vegetables. Thus, there are basis to use the organism in Miura Peninsula. As I showed in Chapter 2, the sustainable agriculture that uses organisms is conducted remarkably not only in the vegetable production as in this case study but also in farming in urban suburb. Farming in the city in the urban suburbs supply fresh vegetables that have high additional value by using organisms. The main reason they produce vegetables is that there is locational advantage in using organic waste.

Corporation E, which connected the organic waste generators and consumers, has managed not only waste collection but also waste recycling treatment. Corporation E is located in the vicinity of the highway like the organic waste generators, and the accessibility to the waste generators is high. Togawa (2001) points out that the waste collection and conveyance contractors tend to be located in and around major manufacturing industry, which is also a waste generator. In the case of high decomposability waste, it is impossible to ship it long distance. In their study of the rendering business, Togawa and Matsunaga (1997) found that the waste collection and conveyance contractors are located in the middle of organic waste generators and consumers. Corporation E in this case study also deals high decomposability garbage, even though there is distance to the waste generators. However, the result of my study confirmed that. The shipping ability of Corporation E is also high because they are located close to the highway, which is a good access point to other businesses. Consequently, types and conditions of organic waste influence the location of waste collection and conveyance contractors.

Furthermore, Togawa (2001) indicates that the waste-recycling contractors also depend on the location of major manufacturing industry, and are located in medium accessible points between organic waste generators and consumers. The reason that the waste generators influence the location of waste-recycling contractors is that the waste collection and conveyance contractors often make deals with waste generators by considering accessibility to them generators. In other words, the shipping cost, including transport of raw material compost in and out influences the recycling contractors location. Corporation E receives organic waste two or three times a day because of the waste collection business. Therefore, the location of Corporation E was strongly influenced by the location the waste generators rather than consumers of the organic waste products. The location of Corporation E had an advantage of collecting organic waste because the plant that discharged organic waste was in close proximity.

On the other hand, according to the interviews, a limit of the product delivery distance reaches as much as 200 kilometers. Since organic waste consumers like the Recycling Union are grouped, which reduces the shipping cost, even if there is a long distance for shipping it becomes an advantage for waste-recycling contractors. Thus, the location of waste-recycling contractors is transportation-orientated. However, in the case of Corporation E, the location is near the waste generators but away from residential areas with consideration for odor pollution. The research of Togawa (2001) shows that the waste-recycling contractors have become the disliked facility with rising environmental problems in recent years, and now tends to relocate to the under-populated area.

One of the characteristics of Corporation E is the existence of person who relates to adjust the inventory in the distance. Because the waste-recycling contractors are mostly located in cities, they do not have enough lots for compost treatment and storage. In order to manage the business without trouble, it is necessary to raise the turnover ratio of the commodity or to have an alternative place where the inventory is stocked. Most inventory storage facilities are similar waste-recycling contractors, as I showed in the previous chapters, and there is a deal regardless of the distance for the stability of business management. Accordingly, organic waste-recycling contractors did not necessarily show transportation-oriented locations because of the problems of odor pollution and adjustment of inventory products.

In sum, characteristics of a large city including the agglomeration of the industry and the sustainable agriculture that use organisms are identified in

Tokyo Metropolitan Area. Organic waste utilization systems have formed in Tokyo Metropolitan Area as a result of each actor's characteristics, business interests and relationships, location, and large area of shipping functions that organic waste contractors covered.

CHAPTER 7
CONCLUSIONS

The result of mass production and mass consumption in the human society, various environmental problems as for waste disposal have become increasing such as illegal dumping, odor and it causes toxic material. Since 1990, various laws related to environmental protection have been enforced for the formation of a sustainable society. These laws promoted recycling and effective utilization of industrial waste. Since a large amount of organic waste is discharged, it particularly expects to be used as a fertilizer, and reorganization of the fertilizer industry was expected. However, the supply and demand of organic waste is unevenly distributed. In addition, few waste-utilizing compost centers function efficiently and continuously. Therefore, the purpose of this study is to elucidate organic waste utilization systems through the analysis of the relationship between waste generators, consumers of organic waste and locations. In the research, the recycling concept that is related to sustainable society is adapted to the food system theory. The interrelationship between actors related to organic waste treatment was analyzed, and the data was integrated in order to elucidate organic waste utilization systems.

Manufacturing industries discharges the largest amount of organic waste. On the other hand, sustainable agriculture is defined as an index to understand waste utilization because fertilizers and feed are the major recycled products of organic waste. Both are distributed in metropolitan areas. The manufacturing industry and sustainable agriculture are distributed throughout the inner city and urban suburbs of Kanto District. Therefore, the case studies were selected from the above region; these included a waste generator—Corporation A, which was a soft drink manufacturer, consumers of organic waste—the Recycling Union of Miura Peninsula, and a waste contractor—Corporation E. The characteristics of the management of business, interrelationship with respect to dealings, and the location of each were examined.

First, the characteristics of the business management of each actor were considered. Since Corporation A belonged to the private sector, its business management was greatly influenced by external factors such as demands and laws. Despite the high costs involved, Corporation A adopted recycling as the method of waste management after the acquisition of environmental certification and enforcement of the WPDC Law. Corporation E had to change the production methods each time depending on the types and amounts of waste available. In addition, the control of supply and demand is an obstacle to the management of business because there is a seasonal demand for the products. It is controlled by cooperation with the consumers, i.e., the farmers and the compost-producing corporations. Moreover, the network forms contracts with the carrying origins and supply destinations of commodities in Corporation E with waste contractors and farmers. The principle feature with respect to consumers is the seasonal compost use, which occurs because the rate of fertilizer application changes with crop type and soil condition. Further, there are differences in the types and amounts of the products ordered and the process of the second fermentation by the size of farm management.

Second, the order of priority of the organic waste dealings is consumer with high usage, waste contractor, and waste generator in the interrelationship between the actors. This result reflects the characteristics of the management of each case. For instance, external factors such as laws and increasing environmental problems have forced the waste generators to undertake waste management. Therefore, the priority of the waste contractor in the dealings is high. The waste contractor has to improve the commodity turnover rate to compensate for instabilities in the demand and supply balance with the cooperation of the consumers. Accordingly, in the relationship between consumers and waste contractors, the consumers have the rights to take decisions in the dealings.

The actual conditions of organic waste distribution were added to the analysis of the interrelation between actors in business relations. As a result, the waste contractors maintain the relationship between the other two actors of the organic waste utilization systems. This relationship between the two actors reflects their position in business management. Hence, for the existence of organic waste utilization systems, a dealing that supplements the disadvantage of each actor is preferred. For instance, waste generators could not handle waste disposal; however, the waste contractors were able to handle it. Further, organic waste consumers request low-priced products that would facilitate the growth of good-quality crops; they also request delivery of the product to avoid carrying it. Therefore, the waste contractor serves these two customers in exchange for the price, and is responsible for forming a relationship between the waste generators and the consumers. In addition, the problem faced by the management in terms of maintaining the balance between supply and demand is solved by double adjustment with the cooperation of waste contractors and farmers.

Finally, the location of each actor was examined. The organic waste utilization systems evolved due to the discharge of large amounts of organic waste by industries and the use of large amounts of compost raw material by farmers in the same region. Waste contractors form a relationship between the waste generators and consumers depending on the location of the waste generator. Additionally, it is important to note that the network of waste contractors forms the waste distribution system.

If the organic waste utilization systems have continued, the waste utilization has promoted. It is a big issue for the waste generator to reduce the amount of discharged waste in order to reduce the disposal cost. On the other hand, the waste contractor faces problems in adjusting the balance between demand and supply. In this study, it was observed that the trust and cooperation of the customers greatly contributes to adjustment inventory. Therefore, it can be concluded that mutual trust is of great importance in continuous dealings. As indicated by Akimoto (1994), it is necessary to consistently supply the consumer with a low-priced and good quality product. In addition, it was found that a consumers' feedback with respect to requests for products and the services of waste contractors influences the continuous dealings between waste contractors and consumers in this study.

In this study, in addition to the characteristics of business management, business relationships, and location of each actor, the factors that form the basis of continuous organic waste utilization systems could have been investigated. The clarification of the roles and business characteristics of the waste contractor and of the waste distribution structure, which have thus far been unclear, has contributed to this. On this basis, it can be considered that this system applies to the cases in which the waste generator is a part of the food manufacturing industry, the waste contractor belongs to the private sector, and the consumers are farmers. The consumers consider organic waste without animal excreta to be industrial waste. This consideration prevents the consumer from using organic waste. Therefore, in order to dispel the consumers' doubts, it is necessary to publicize information regarding organic waste as well as provide quality certification.

It may be worth pointing out that there is a limit to the amount of organic waste that can be used as manure. Although this aspect has not been dealt with in this study, it has been indicated by Nishio (2001). The production of energy from waste, such as methane and alcohol fermentation, and material utilization, such as lactic acid fermentation, has been recently developed as the solutions for the reduction of organic waste[35)]. Research on these processing technologies and systems has been recently started. Therefore, for the promotion of resource circulation, it is necessary to examine the socioeconomic structure and the probability of propagating of waste-utilization methods other than composting. Moreover, this study was not concerned with the quantitative analysis of reduction in environmental stress by organic waste utilization. Recycling has not completely reduced environmental stress. This aspect needs further discussion.

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NOTES

1) NIMBY stands for 'Not In My Back Yard.' This indicates a facility that a social necessity, but is disliked by local residents. In a sense, it is the facility that implies the resident egoism in a sense. Examples of NIMBY include an industrial waste treatment facility, a landfill disposal site, and a funeral and crematory.

2) According to statistics of the Ministry of the Environment, in 2000, 52.36 million tons of domestic waste was discharged, and 406 million tons of industrial waste is discharged.

3) The 'Law of Introduction Promotion of Agricultural Production Method with High Sustainability' and the 'Law on Promoting Proper Management and Use of Livestock Excreta' were enacted in 1999. In addition, 'Basic Law for Establishing the Recycling-based Society' that were enforced in June 2000 included 'Waste Disposal and Public Cleaning Law,' 'Law for the Promotion of Effective Utilities of Resources,' 'Law for Promotion of Sorted Collection and Recycling of Containers and Packaging,' 'Law for Recycling of Specified Kinds of Home Appliances,' 'Law and Policy of Waste Materials from Dismantled Residential Buildings,' 'Law Concerning the Promotion of Recycling Food Cyclical Resources,' and 'Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services' by the congress.

4) Organic waste is defined as the resource that originates in living things. For instance, organic waste includes household garbage, sludge from the food industry, animal excreta, straw, and wood chips. These can be reduced in the environment by biodegradation and become a useful resource again.

5) The report calculates gross waste weight from a material of 1996 and estimates the ratio of organic waste generation from a material from 1993 to 1996.

6) This term is a metaphorical description to compare the phrase "Metabolism between man and nature" to the circulatory system of the human body (Togawa 2000). The manufacturer is called the '*arterial industry*', and the waste management business is called the '*venous industry*.'

7) Data were collected from August, 2002 to March, 2004.

8) Refer to 'Note' in Figure 2.

9) It is expected that there are many compost in the outside market although the statistics of fertilizer marketing excludes the dealings between farmers.

10) The sewage sludge is estimated as a thick sludge, and the ration of recycling includes the use for the building material.

11) Beauchesne and Bryant (1999) investigate specialized organic farming.

12) A related entrepreneur is business related to the soft drink industry such as raw material, material, equipment and machine, equipment for sales, apparatus and other.

13) This is an international standard of the environmental management system that International Organization for Standardization issued. The aim is to reduce the harmful stress given to the environment by improving the environmental management system continuously.

14) HACCP is a management system prevents occurrence of harm in food.

15) Corporation A has 35 factors in Japan.

16) Corporation A manages not only Ebina but also Shizuoka.

17) Logistics center has the function of adjustment and control that substantial reductions in distribution cost and improvements in service have been realized by eliminating waste in the distribution process.

18) Dregs hopper is a temporarily storage discharged waste, a device on the funnel that opens a lower mouth if necessary and puts it out.

19) Manifest is an indent to confirm the delivery to each contractor at the stage of discharge, transportation and disposal of industrial waste. Name, kind, and the condition of industrial waste are describes in the manifest. Waste generators can manage waste flow.

20) The WDPC Law regulates that industrial waste contractor has permission of collection and conveyance business or disposal business from the administration.

21) The corporation that acquires ISO14001 has already exceeded 10,000 throughout Japan.

22) The amount of moisture after the recycling process is approximately 50% in Corporation E.

23) Quoted from '*Agriculture in Miura Peninsula,*' it's a material of agricultural improvement promotion conference in Miura Peninsula.

24) This ration was divided from 2,009 farm households into 1,612 hectares of total management arable land.

25) '*Onbaimo*' is a potato that is unsold; it is a small potato that grows as a seed potato. It had grown in present Miura City, Minamishitaura-machi since the beginning of Taisho era (1912).

26) We can know the heavy labor for carrying the compost at that time from the following states. Endo (1974, p. 67) shows 'it takes at least half a day to collect cattle manure of 50 kilometers in one way in the case of Miura City. It takes a day including carrying and turning of manure. It costs about 9,000 yen for 2 tons of drying manure by adding the labor expense 3,000 yen and fuel cost 600 yen.'

27) Antagonistic plant is a mainly non-legume that has disease control and desalinization effect in the fields, is like marigold, wild oats, and guinea grass. These are useful as green manure crops by plowing into the field.

28) This is estimated by Namai et al. (1991, p. 477) that 'the amount of annual use of animal manures were 8,800 tons in Miura City at the time and the manure from outside city reached 6,500 tons.'

29) Planted area of green manure crops is over 110.44 hectares in Miura Peninsula as of 2001.

30) The union contribution was abolished in 1999 though 500 yen a year as a union activity expense was collected at the beginning of the union.

31) There are some farmers who don't apply fertilizer for winter cropping because the constituent of compost is applied for summer cropping has been still residues in the soil or it is a plowed-in vegetable residual material in summer cropping.

32) Additional manure for spring cabbage is applied 500 kg per 10 acres. However, organism is rarely used, because organism, which is not drying much, leads to occurrence of the insect pest in winter cropping.

33) The solar energy drying is to promote the fermentation of immature composts by repetition of cover on outdoor fields with a vinyl for killing out miscellaneous germs through solar heat (Suzuki 2002).

34) The flow of goods is compared to the flow of a river in the technical terminology of distribution businesses. The production is called the upper stream division, marketing is called the midstream division, and consumption is called the downstream division.

35) The method to reduce nitrogen is to control the food import and to raise the food self-support ration in domestic.

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