

Structural Changes in Fertilizer Circulation in Modern Japan: Analysis Based on the Change in Relationship between the Use of Night Soil and the Disposal of Human Waste

Noriko Yuzawa

Hosei University, Japan



© 2024 Noriko Yuzawa

<https://doi.org/10.26493/978-961-293-399-9.175-187>

Introduction

This study examines the structural changes in material cycles that accompanied economic and social changes in Japan during the nineteenth and twentieth centuries. In particular, we focus on the use of night soil in agriculture and sewage treatment in cities, and highlight the changes in the relationship between the two.

Agriculture is intrinsically based on the cycle of materials. Materials and their cycles are closely related to the natural conditions and agricultural technology of each era and region and change accordingly.

Take the example of fertilizer: in the Edo period, various organic materials such as grass, seaweed, shellfish, and animal dung were brought to agricultural lands, much of which was human waste. All of these were important fertilizers for farm self-sufficiency. As crop production increased, purchased fertilizers such as fish fertilizer (made from fish waste) and soybean meal were introduced for the market. Guano (bird droppings) was also newly introduced as a fertilizer, along with chemical fertilizers. The introduction of such fertilizers and their combinations led to changes in the mechanism of ‘self-sufficient material cycles’ within management

Murayama, S., Ž. Lazarević, and A. Panjek, eds. 2024. *Changing Living Spaces: Subsistence and Sustenance in Eurasian Economies from Early Modern Times to the Present*. Koper: University of Primorska Press.

in the region as a whole. In particular, the linkage to the market economy through fertilizers and the entry into land-intensive agriculture as part of modern Japanese agriculture are noteworthy as major structural changes in the material cycle linking the soil and the dining table.

As for urban areas, cities in Japan developed in the nineteenth and twentieth centuries and experienced rapid population growth during the Industrial Revolution. While demand for food increased and agriculture flourished, the disposal of human sewage in cities became a problem. Accordingly, Japan experienced a major structural shift in material cycles in both rural and urban areas in this.

This study discusses the structure of the material cycle of fertilizers from the perspectives of agricultural and economic history, using Aichi Prefecture as a case study. In particular, we focus on Nagoya, which underwent remarkable urbanization, and the farming villages on the outskirts of the city, which played a role in supplying food to the city. Aichi Prefecture was selected because it experienced a notable increase in industrial production in modern times, while becoming one of the country's leading agricultural production areas. It has both agricultural and industrial characteristics.

In the following sections, we discuss the development of agriculture and changes in fertilizer use in Aichi Prefecture (Section 2). In particular, we examine the actual status of the use of night soil as a valuable material in terms of the relationship between urban areas (Nagoya) and suburban farming villages. Next, we clarify the state of urbanization in Aichi Prefecture from the Taisho period to the early Showa period and describe the problem of human waste disposal, which became an urban problem due to population growth (Section 3). Using Nagoya administrative documents, we focus on the history of attempts to municipalize human waste disposal. Finally, we discuss and summarize the structural changes in the material cycle between rural and urban areas (Section 4).

Agricultural Development and Fertilizer Consumption in Aichi Prefecture in the Early Twentieth Century

Urbanization, Industrialization and Rural Areas in Modern Aichi Prefecture

Agriculture in Aichi Prefecture underwent significant changes in the twentieth century. The first factor was the shift to commercial agriculture for vegetable and fruit crops and livestock (including poultry) due to

Table 1 Trends in Agricultural Production in Nakashima-gun

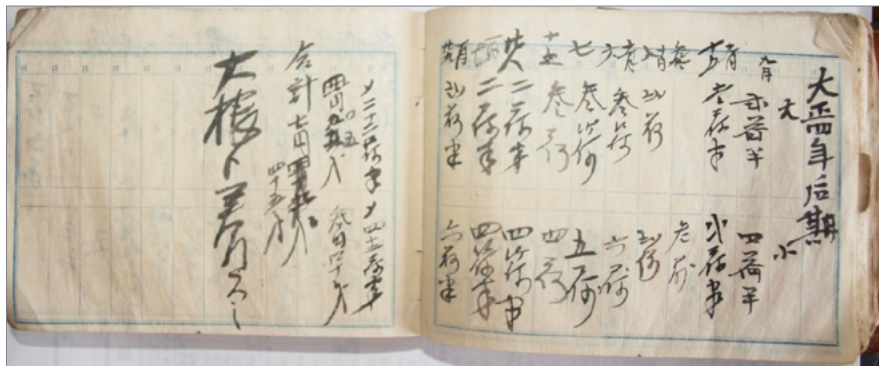
year	rice	wheat	cotton	indigo	mulberry	Japanese radish	vegetable
1887	5.862	3.247	1.095	850	—	—	—
1897	6.529	3.859	79	1.005	411	—	—
1907	6.846	4.071	13	146	455	651	—
1917	6.804	3.729	1	120	794	1.044	—
1927	5.950	2.851	2	34	998	837	2.141
1937	6.078	1.074	2	1	516	722	2.322

Source: Aichi Prefecture (1887; 1897; 1907; 1917; 1927; 1937).

1) The numbers after the decimal point are rounded off. 2) 'No description' is indicated by — 3) The unit 'chou' is about the same as ha.

the need to provide food for urban consumers and factory workers. The cultivation of vegetables, such as Japanese radish, experienced a remarkable increase. For example, table 1 shows changes in crops in Nakashima-gun, a wool-producing area in Aichi Prefecture.

At the end of the nineteenth century, cotton and indigo were grown as raw materials for hand-woven cotton textiles, in addition to the main crops of rice and wheat. However, the textile industry gradually became mechanized and electrified, imported cotton was introduced, and Japanese cotton with short fibres was no longer used. Due to imports from India and the introduction of chemical dyes, domestic production of indigo gradually ceased. While cotton and indigo declined, production of vegetables, especially Japanese radish, increased as demand for vegetables increased in Aichi Prefecture and industrial areas such as Osaka and Kobe (Yuzawa 2015).

**Figure 1** Fertilizer Trading Book, 1915

Source Takashi Suzuki, o873.

Under these circumstances, there was a need to improve crop productivity, and fertilizer consumption in Aichi Prefecture increased year by year. It was important for farmers to use existing resources as much as possible so as not to rely on expensive purchased fertilizers. In Aichi Prefecture, poultry manure from poultry farming and human waste, which increased with urbanization, became important fertilizers in terms of self-sufficiency.

Examining the wool industry that emerged in Aichi Prefecture at the beginning of the twentieth century, the waste of workers collected from factories was sold to surrounding farming villages and returned to farmland as 'night soil'. Document 1 is a record of the trade in human waste as fertilizer from a textile factory. They traded with about ten farmers. This page is a record of transactions between a farmer and a factory in late 1915. Faeces and urine are recorded separately, and the total amount is given. Interestingly, payment was made in Japanese radish. Other pages show farmers buying night soil in exchange for in-kind payments such as straw and eggs, or daily wages for cloth factories.

The Industrial Revolution led to the creation of factories and the accumulation of workers, which increased both the demand for food and food production. In other words, a circular structure was created in which the human waste of workers was used as fertilizer for food production and workers ate the Japanese radishes supplied as payment.

In addition to these exchanges between individual factories and farmers, there were increasing discussions in Aichi Prefecture about agricultural production and fertilizers. For example, the prefectural Agricultural Experiment Station pointed out that although total fertilizer consumption in the prefecture was increasing, productivity was not, which was attributed to farmers' inadequate knowledge of fertilizers. Therefore, in 1916, the Agricultural Experiment Station published *The Story of Fertilizers*, a technical book on fertilizer use that promoted efficient farming with fertilizers (Aichi Prefectural Agricultural Experiment Station 1916).

According to the book, in the past, when the land was large and the population small, it was possible to let the land lie fallow and cultivate it for several years, and it was assumed that it would then recover. However, due to population growth, the same land was used two or three times a year to harvest crops. This increased the need to add fertilizer to the soil at each harvest and maintain its fertility.

Three components in particular, nitrogen, phosphoric acid, and potassium, are essential components of fertilizers. Nitrogen is found in com-

post, ammonium sulphate, herring meal, soybean meal, oil cake, and so on. Phosphoric acid is found in superphosphate lime, bone meal, guano, phosphorus ore, oil cake, rice bran, and so on. Potassium is found in straw ash, wood ash, soybean meal, soybean meal, cottonseed meal and so on. The text carefully introduces these formulations and fertilization methods for each crop: rice, wheat, vegetables and fruit trees.

In addition, a technical book on agriculture, *Night Soil*, was published by a general publisher in 1914, containing the composition of human waste and methods of decomposition, storage, use, odour control, and disinfection, and discussing the scientific basis for using human waste as fertilizer. The use of night soil continued, but the addition of scientific evidence and justification rather than the continuation of traditional practices was a sign that the technology had reached a new stage (Tsubame 1914).

Fertilizer Consumption Structure in Aichi Prefecture

The Aichi Prefectural Agricultural Experiment Station emphasized the need for organic matter and specifically explained the three elements of fertilizers and their composition. Human waste was therefore considered an indispensable ‘organic fertilizer’ for farmers.

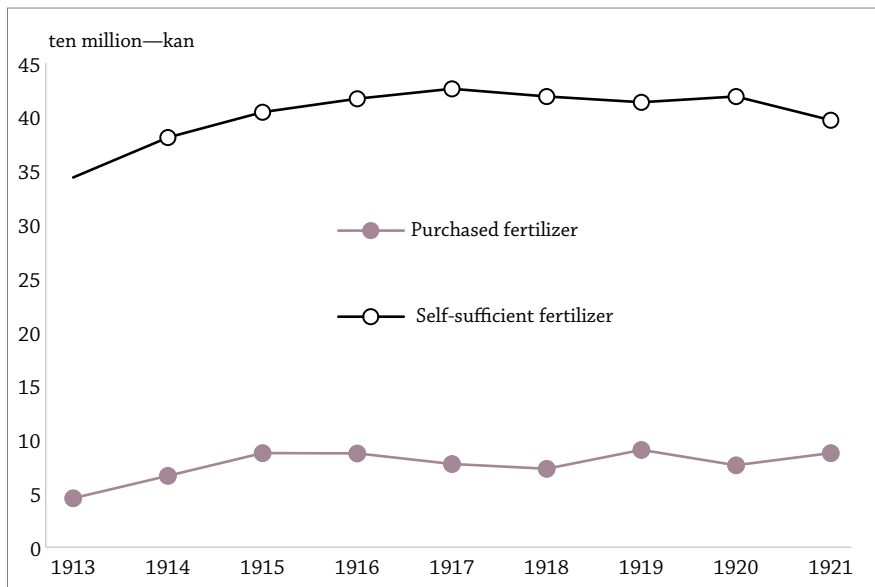


Figure 2 Trends in Fertilizer Consumption in Aichi Prefecture (Weight)

Source Aichi Prefecture Industry Department (1923, 43–6).

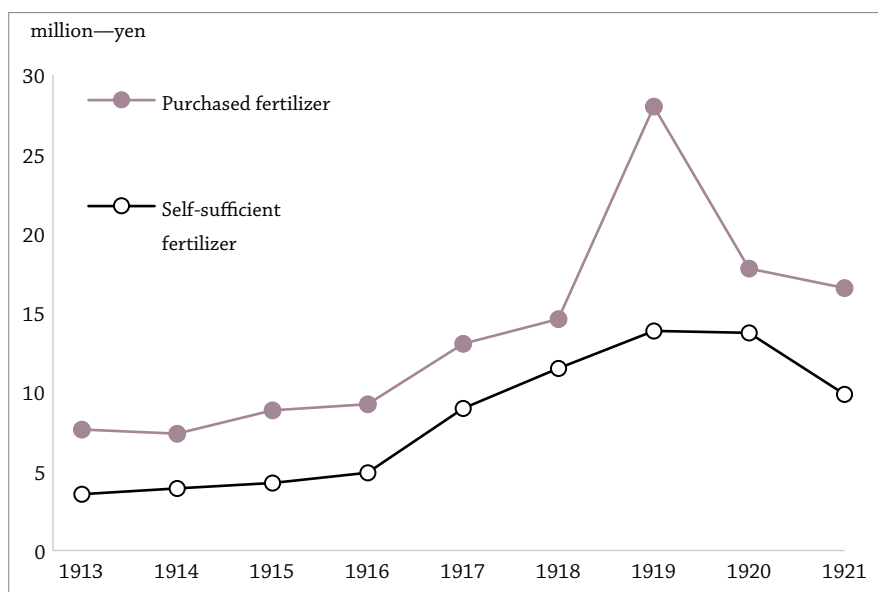


Figure 3 Trends in Fertilizer Consumption in Aichi Prefecture (Amount of Money)

Source Aichi Prefecture Industry Department (1923, 43–6).

According to the Station, population growth and improvements in living standards increased the demand for vegetables. In addition, a complete transportation system made it possible to transport vegetables out of the prefecture. As a result, vegetable cultivation developed rapidly and the production value reached high amounts; it is now the only cultivation area in Japan (Aichi Prefectural Agricultural Experiment Station 1919).

Looking at the structure of fertilizer consumption in Aichi in 1913, purchased fertilizer accounted for 13.4 percent of total consumption and self-sufficient fertilizer accounted for 86.6 percent. The proportion of self-sufficient fertilizer was significantly high, and human waste as self-sufficient fertilizer accounted for the highest proportion of total consumption, 38.4 percent. On the other hand, purchased fertilizer accounted for 67.7 percent of the total amount by value, which was significantly higher than the 32.3 percent of self-sufficient fertilizer. In other words, at that time, fertilizer consumption in Aichi Prefecture depended on a large amount of self-sufficient fertilizer, which in some cases was used alongside expensive purchased fertilizer.

This structure was maintained, but if we consider the consumption amount as an index, we find that the fluctuation increased from 1916 (figure 2 and 3).

Agriculture and Fertilizer Consumption in Suburban Rural Areas

What are the experiences of farmers in this situation? In the following, fertilizer is examined on a micro-scale using Kachigawa-cho, Higashikasugai-gun, near Nagoya.

Although Higashikasugai-gun is adjacent to Nagoya, it has a high percentage of full-time farmers and has become a suburban farming area supplying food to the cities. The number of farmers in the county is relatively high. With the development and expansion of Nagoya, the demand for vegetables increased due to population growth, and this region developed into a vegetable supply site.

Against this background, village farmers' associations tried various approaches to fertilizers. For example, they promoted the use of fertilizers for self-sufficiency against the decline in rice prices in 1915, and the following year they promoted the construction of composting houses and held compost fairs. To promote the cultivation and spread of plants that fix nitrogen, they organized the joint purchase of seeds of Chinese milk vetch.

However, as the total consumption of purchased fertilizer continued to increase, the actual management of farms relied on the use of fertilizers for self-sufficiency. For in addition to the increased tax burden, it was necessary to buy seeds and seedlings in cash.

For example, consider the business development of a farmer from the 'Farmers' Economic Survey'. This farmer was mainly engaged in rice cultivation and added sericulture and poultry farming to his combined cultivation. In order to improve the economic position of poultry farming and strengthen it, poultry manure was used to increase the productivity of various vegetables. As the improvement of agricultural management came to the fore, the trend of agricultural management costs also changed. It is obvious that the introduction of seeds, seedlings, fertilizers and feeds were essential to improve agricultural production. They consistently accounted for about 60 percent of farm management costs. The cost of purchasing fertilizer gradually increased, from 212 to 378 yen in 1923, but thereafter fertilizer costs decreased due to the success of fertilizer self-sufficiency (Aichi Agricultural Association 1923).

Now let us look more closely at changes in feed costs, fertilizer costs, livestock costs, etc. over time. The Farmers' Economic Survey distin-

guishes between ‘for sale’ and ‘for own use’ with respect to income and between ‘in cash’ and ‘in-kind’ for expenditures. The ‘for sale’ crops and the ‘cash’ expenditures are the flows directly related to the market economy. On the other hand, ‘own use’ crops destined for subsistence and ‘in-kind’ expenditures circulate in the farm economy, which is maintained by adjusting the balance between the two.

This farmer increased the amount of rice produced for his own use and specialized in raising poultry for sale. Night soil was included in the ‘other’ income, which is available only in the data from 1928, but all are for subsistence. Looking at farming costs, the proportion of expenditures for seeds, seedlings, feed, and chemicals purchased ‘in cash’ tends to be consistently high, but only fertilizer expenditures are liquid in the proportions of ‘cash’ and ‘in-kind’. In the case of this farmer, it is noteworthy that ‘cash’ expenditures for fertilizer gradually declined from 1923 to 1930. In other words, by reducing the use of purchased fertilizer and increasing the proportion of self-sufficient fertilizer, he was able to reduce the burden of increased costs for seed, feed, and chemicals.

Thus, for individual farmers, increasing the ratio of self-sufficient fertilizer served as an adjustment value to maintain stable farm management.

Urbanization and Municipal Management of Human Waste in The Modern Aichi Prefecture

The Emergence of Industry and the Expansion of Nagoya

As we have seen, agricultural production became more active in modern Aichi Prefecture, and suburban farming villages developed, maintaining a balance between purchased and self-sufficient fertilizer. However, rapidly expanding cities and their growing populations became a new urban problem that went beyond tolerating the return of human waste to farmland. This section addresses the effects of urban expansion.

How did the population and urban areas of Nagoya change during this period? Below, we examine the case of Nagoya, which has the largest population growth in Aichi Prefecture.

As shown in figure 4, the population of Nagoya increased rapidly from the end of the nineteenth century to the first half of the twentieth century. In particular, there was a remarkable increase from 1920, with a constant increase of about 200,000 people per decade. This population increase was clearly related to the expansion of the Nagoya urban area.

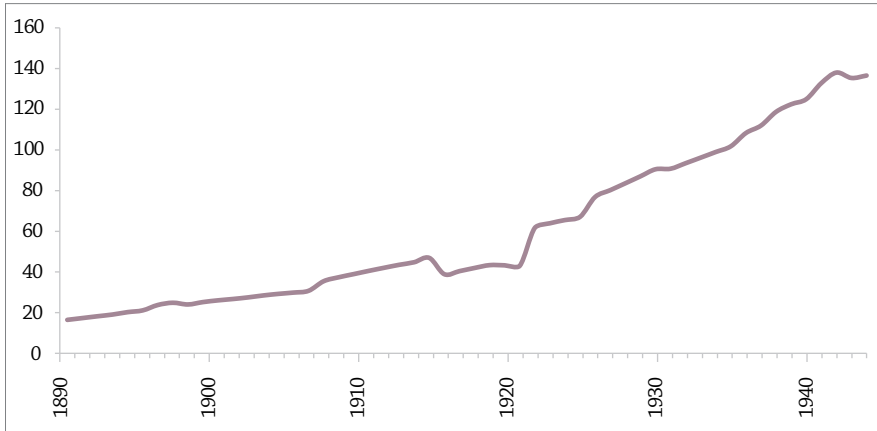


Figure 4 Population Transition of Nagoya City from Taisho Period to Early Showa Period

Source Nagoya City.

In Nagoya, in addition to the rail lines already laid in 1900, new rail lines were laid in 1923 to further surround the urban area, and by 1935 the urban area had expanded beyond the railroad.

Waste Disposal from the Urban Perspective of Cities: Municipal Involvement

As the city grew and the population increased, the volume of human sewage also increased proportionately. Nagoya was one of the first cities to address the treatment of this growing volume of sewage. In 1911, the mayor of Nagoya summarized the reasons for municipalizing waste treatment in three points: (1) the harmful effects of excrement, (2) urban sanitation, and (3) the right of citizens to dispose of waste (Himeta 1915, 11–5).

We address the negative effects of the first point: (1) collection is delayed during the peak agricultural season, and when it rains, drinking water inside and outside the house becomes impure; (2) farmers only collect the manure parts, and the remaining parts are not cleaned; (3) the human waste containers used by farmers are poorly made so that they emit odour, which is a hygiene problem; (4) some farmers use the same containers to transport vegetables; (5) there is a possibility of contagious diseases in the human waste; (6) there are many carriers of intestinal parasites in the region, which are transmitted from vegetables fertilized directly with human waste.

Table 2 Law and Policy Concerning Disposal of Human Waste

Year	Event
1900	"Dirt cleaning law" established. However, excluding human waste.
1910	Amendment of waste cleaning law. By doing this, it is decided to process waste sewage if necessary for each area. ♦Applied to Aichi prefecture governor for the need for municipal waste management.
1911	♦The mayor responded regarding the impact of municipalizing manure disposal on citizens and farmers. Nagoya city decided to commission a company to manage sanitary disposal for the whole city.
1912	♦In Nagoya city, human waste treatment was carried out by the municipal government. This was the earliest practice nationwide.
1930	The dirt cleaning law is amended. Administrative responsibility for human waste disposal increases. It was decided that human waste was included in the waste.

Note ♦ Events related to Nagoya city.

Source Nagoya City History (2000, 133) and Hayato (1915).

As described above, the waste problem in cities became serious from the end of the Meiji era, and the established conventional methods and customs were no longer viable. In terms of hygiene and public health, the habits of the past were termed 'evil habits'. The idea that municipal revenues could be generated by treating and using sewage prompted the Nagoya Municipal Government to explore municipal management of waste treatment.

Until about 1912, human waste collection in Nagoya was handled through direct transactions between farmers and households in the city, and farmers supplied vegetables as payment for the waste. Although the Waste Cleaning Law was enacted nationwide in 1900, it excluded sewage in accordance with the practice of the time. This was a measure that recognized the use of night soil as fertilizer (table 2).

However, with the rapid increase in population, more human waste was discharged than could be used as night soil, and the old practice became unsustainable. Rural areas around Nagoya began to enact regulations for night soil and negotiate with city residents to stabilize the price of collection. In addition, farmers boycotted human waste collection and demanded lower prices for night soil. This was because prices were beginning to fall due to the oversupply of human waste. Thus, in the middle of the Meiji era, the relationship between rural and urban areas in terms of excrement extraction changed significantly.

However, due to continued population growth and associated waste, returning waste to rural areas as the only method of disposing of human waste was no longer practical, and Nagoya sought an alternative meth-

od. In 1910, the Waste Cleaning Law was revised, and the administration became actively involved in waste disposal, with the handling of human waste entrusted to prefectural governors.

In major cities such as Tokyo, Osaka, and Nagoya, the need for municipal management of sewage treatment increased since the 1900s in order to secure financial resources for water supply and sanitation. Nagoya, in particular, is said to have pushed for municipalization of wastewater treatment more out of financial necessity than for public health reasons.

According to a survey conducted by the Nagoya City Sanitation Division, in July 1921 the daily excreta volume of the entire city was about 700,000 litres, of which about 150,000 litres was excess human waste that could not be treated. In addition, as urbanization took place, land formerly used for agriculture was converted to housing or factory use, and rural areas were moved to the outskirts of the city. As cities grew, transportation costs increased, more human waste was retained in cities, and disposal became a major social problem.

Under these circumstances, it became necessary to increase government involvement in sewage treatment. In 1930, the Waste Cleaning Law was amended to include human waste, which had previously been excluded from it. This was a problem not only in Nagoya but also in other parts of Japan.

Conclusions: Stepwise Reconstruction of the Material Cycle

This study illustrates the structural changes in the material cycle of modern Japanese agriculture by focusing on the changes in fertilizer technology in Aichi Prefecture in the early twentieth century. In particular, we examined the conflict between the use of night soil and the processing of human waste from both rural and urban perspectives. With regard to the return of human waste to farmland, i.e. its use as night soil as a single material cycle, a decline has been observed in the modern era.

This study concludes that it is not a decline but a gradual reconstruction of the material cycle. This is because, as we have seen, the use of night soil continued to coexist with the processing of human waste. Subsequently, night soil continued to be used as a self-sufficient fertilizer during and after World War II due to the shortage of materials. Therefore, the use of night soil continued in Japan at least until the 1960s.

When it comes to the restructuring of the material cycle in modern times, rapid urbanization and population growth are both important events. The rapid increase in population resulted in a massive ex-

cess of human waste, although the resulting increase in food production increased the need for fertilizer. Although some of the manure was returned to farmlands and contributed to agricultural production, by the 1900s, the large amount of residue had become a social problem, causing foul odours and unsanitary conditions. This was the result of the rapid increase in the amount of material, which could no longer be handled by the existing circulation structure. Due to the excess, the price of human waste decreased and a campaign to reduce collection fees was launched. The need to dispose of the large amounts of human waste that could not be returned to agricultural land continues to increase, and Nagoya has changed its policy about every decade to address this problem.

Thus, since modern times, the circular structure of materials has been gradually reshaped, in the wake of overwhelming quantitative changes in the population. As far as this study is concerned, the material that most reflects this effect is human waste, used as night soil and processed as sewage.

As a preliminary note, it was a process in which the material cycle absorbed new materials and a new logic, transforming into a new cyclic structure closely linked to the market economy. Both the use of night soil in rural areas and the treatment of sewage in urban areas are similarly important actors.

The non-monetary world of the farm economy, that is, the material cycle of self-consumption, was generally considered a world separate from the market economy and even from the capitalist economy. However, the increase and refinement of the use of night soil through the development of vegetable cultivation for urban consumers, the improvement of the pumping and distribution system, the combination of chemical and organic fertilizers, the stabilization of the farm economy through self-sufficient fertilization, and the conflict between the use of night soil and sewage processing, as illustrated here, cannot be explained without the influence of the market economy.

In other words, the material cycle in the modern era, the transition period to the market economy and society, affected both the individual farm economy and the market economy, and consequently, the gradual structural change of the material cycle led to the fundamental support of the market economy. In addition to Aichi Prefecture, it is necessary to further explore this point through comparative analysis in other prefectures, including the relationship between rural and suburban rural areas; future studies may address this.

Acknowledgement

Some of this content was presented at the 2018 World Economic History Conference in Boston. This study is the result of an ongoing project, which is funded by Grants-in-Aid for Young Scientific Research (B) (25770293), supported by the Japan Society for the Promotion of Science from April 2013.

Archives

Takashi Suzuki, Document No. 0873.

Literature

- Aichi Agricultural Association. 1923. *An Economic Survey of Individual of Farmers*. Nagoya City: Aichi Agricultural Association.
- Aichi Prefecture. 1887. *Aichi Prefecture Statistics*. Nagoya City: Aichi Prefecture.
- . 1897. *Aichi Prefecture Annual Report*. Nagoya City: Aichi Prefecture.
- . 1907. *Aichi Prefecture Statistics*. Nagoya City: Aichi Prefecture.
- . 1917. *Aichi Prefecture Statistics*. Nagoya City: Aichi Prefecture.
- . 1927. *Aichi Prefecture Statistics*. Nagoya City: Aichi Prefecture.
- . 1937. *Aichi Prefecture Statistics*. Nagoya City: Aichi Prefecture.
- Aichi Prefectural Agricultural Experiment Station. 1916. *Hiryo no Hanashi*. Kiyosu Town: Aichi Prefectural Agricultural Experiment Station. Aichi Prefectural Agricultural Experiment Station.
- . 1919. *Vegetables of Aichi*. Kiyosu Town. Aichi Prefectural Agricultural Experiment Station.
- Aichi Prefecture Industry Department. 1923. *Aichi Prefecture Fertilizer*. Nagoya City: Aichi Prefecture Industry Department.
- Hayato, H. 1915. *Municipal Management of Human Waste Processing in Nagoya City*. Aichi: Chukyo-do.
- New Work Nagoya City History Editing Committee. 2000. *New Nagoya City History*, 6. Nagoya City: Aichi Prefecture.
- Nagoya City. *Nagoya City Open Data: Trends in the Number of Households and Population*. <https://www.city.nagoya.jp/shisei/category/67-5-5-24-0-0-0-0-0-0.html> (12/12/2024access.)
- Tsubame, S. 1914. *Night Soil*. Tokyo City: Yurindou-shoten.
- Yuzawa, N. 2015. 'The Transformation of the Relationship between Agriculture and Industry in the Modern Bisai Textile and Industrial Areas: An Analysis Based on the History of the Suzukama Factory.' *The Agriculture History Research* 49:41–58.