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The conditions for development of sustainable livestock production including dairy farming

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Introduction

World economic trends have changed greatly in the 21st century, World Trade Organization (WTO) agreements have been promoted on a full scale, and globalization has progressed. Under such circumstances, dairy farming and livestock production are forced to endure fiercely competitive environments due to "structural reform". These reforms have been promoted by setting deadlines for facility developments to comply with the Law on Promoting Proper Management and Use of Livestock Excreta and revising the Deficiency Payment Law (Temporary Law for Compensation Price for Producers of Milk for Manufacturing Use). In order to carry out sustainable dairy farming and livestock production, it is necessary to adopt diversified management styles and management methods. At present, there are three main methods for the management of livestock farming, particularly dairy farming. One of these methods is to push modernization forward. This strategy aims to expand the management scale in many ways, such as increasing the number of cows, and achieving high lactation performance by sustaining high-input agriculture. Another method is to keep the status quo without increasing the number of cows. The last one is to promote "low-input" dairy farming commensurate with workforce and living conditions by decreasing the number of cows. This farming style is called "my-pace dairy farming", which is tailored to each farm's conditions, such as climate, natural environment, and living conditions. As stated above, dairy farming management has been improved in various ways. Therefore, it is necessary to establish and develop a system to maintain these improvements.

From such recognitions, in this thesis, The conditions for formation of sustainable livestock production including dairy farming system and development of this system has been clarified.[1]

1. Improvement of the livestock industry, particularly dairy farming, and its issues

(1) History of dairy farming

Conventional dairy farming management has traditionally been focused on scale expansion with an increase in the number of cows. Following the social trend in which westernized dietary habits were popularized, the demand for fresh milk and dairy products has steadily increased and milk prices have kept rising. As for management styles, dairy farming with single farming management differs from that of conventional multiple or mixed farming. Considering scale expansion and farming management differences, the history of dairy farming is broadly classified into two periods as follows:

The first period (until the late 1970s) shows a dramatic expansion in management scale farming. Full-time dairy farming was promoted mainly in Hokkaido from the late 1960s to the late 1970s by an increasing number of cows, milk production and farm acreage per farm household

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under the policy of "scale expansion without limitation". Even in the second period (1980s or later), the expansion policy was carried over, and was promoted by adjusting the total milk production of all dairy farms and increasing milk production per cow in individual dairy farms. After planned production was introduced to dairy farming in 1979, the overall fresh milk production was controlled and milk prices declined. This situation caused confusion in dairy farming and significantly affected the economy of municipalities dependent on dairy farming. In order to cope with the decline of milk prices, individual farmers sought further scale expansion, which was characteristic of the dairy management of this period, though the adjustment of overall milk production continued. Since the early 1990s, environmentally-friendly sustainable livestock production including dairy farming have been sought after.

(2) Issues concerning high lactation performance and high-input dairy farming

For continuing improvement in dairy farming, the following various efforts have been made: an increase in number of cows, achievements of high lactation performance, a shifting of feedstuff into roughage and purchased feed, expansion of farmland (dependence on commercially-produced cheaper feed and large amounts of milk production per cow, resulting in more feed), the building of more facilities and cattle stalls, and obtainment of a workforce able to cope with the changes previously mentioned. Due to the above changes, the number of cows per farm household increased to a level where family labor was insufficient to manage them. The overall milk production per cow increased and high lactation performance was promoted. However, there was also a negative impact on dairy farming. For example, the demand for fresh milk and dairy products did not expand, and the downward trend of milk prices was accelerated by an expansion of fresh milk price gaps and an increase in the pressure of imported products from overseas. Large amounts of milk production were sought after and a large supply of imported feed under the influence of a strong yen caused the creation of an entire generation of massive quantities of manure and environmental problems (Table 1 and 2). Because of this, the need to install new machinery and facilities arose, and an increase in facility investment put more pressure on farm management. There were also concerns about the safety of dairy products. A large amount of imported agricultural and livestock products, including bone-and-meat feed, was considered to be a factor behind the Bovine Spongiform Encephalopathy epidemic.

To resolve these problems, the Japan and

Table 1 Cultivation acreage of feed crops per dairy cattle (ha)

	1980	1985	1990	1995	2000	2004
Nationwide	0.38	0.34	0.38	0.31	0.34	0.34
Prefectures except below	0.27	0.23	0.30	0.12	0.13	0.13
Hokkaido	0.55	0.51	0.49	0.55	0.57	0.49
Iwate	0.58	0.58	0.71	0.32	0.36	0.27
Tochigi	0.14	0.10	0.11	0.07	0.08	0.11
Shizuoka	0.24	0.10	0.09	0.07	0.07	0.10
Kumamoto	0.23	0.22	0.27	0.11	0.11	0.13
Fukuoka	0.08	0.07	0.09	0.02	0.02	0.07

Source: Taking from the world agriculture and forestry census of each year

Table 2 Number of complaints arising from dairy farming and livestock raising management

	Odor trouble		Water pollution		Pest emergence		Total	
	1998	2003	1998	2003	1998	2003	1998	2003
Dairy cattle	506 (32.0)	557 (33.2)	363 (37.0)	288 (30.8)	51 (18.0)	36 (18.7)	867 (33.5)	863 (32.8)
Beef cattle	164 (10.4)	212 (12.6)	132 (13.5)	172 (18.4)	30 (10.6)	35 (18.1)	306 (11.8)	391 (14.8)
Hogs	581 (36.7)	557 (33.2)	387 (39.4)	373 (39.9)	20 (7.1)	14 (7.3)	823 (31.8)	806 (30.6)
Total	1,582 (100)	1,678 (100)	981 (100)	936 (100)	283 (100)	193 (100)	2,588 (100)	2,633 (100)

Source: Survey by the Livestock Industry Bureau and the Livestock Industry Department of the Agricultural Production Bureau, the Ministry of Agriculture, Forestry and Fisheries

Hokkaido dairy industry are seeking a new direction for farm management improvement.

2. Approach for improvement and issues-new style of dairy farming

(1) Scale expansion, incorporation, and support system

Improvement in dairy farming is generally promoted by the conventional approach based on family-run farms focusing on an increase in the number of feeding animals. There are three directions for the improvement of actual farm management. The first direction is to promote multiple farming through introduction of upland cropping, processing, and handmade products rather than keeping single farming. The second direction is to encourage family-run farms to shift to incorporated management in the form of business organizations. This will lead to the establishment of alliances or partnerships between individual corporations, or incorporation of these entities. The third direction is to incorporate a management entity consisting of family-run farms as a production organization. A recent trend is to introduce economic principles to pursue stable income (profit) by reducing the production cost through management restructuring, while securing the safety of products. For that purpose, it is necessary to expand the scale of management, promote high lactation performance, and shift management styles from family-run operations to incorporated management and large-scale firms. However, the increased number of feeding animals has now reached a limit within the family workforce. Various problems, such as aging of farmers, excessive increases in feeding animals and animal waste treatment and utilization, are coming to the surface. Under such circumstances, it seems difficult to improve farm management by individual efforts or introducing incorporated management alone. A support system for dairy farming is needed for any form of management in the future. The promotion of scale expansion and incorporation may have an impact on the environment and require facility investment. Therefore scale expansion does not always lead to the increase of income. If scale expansion and incorporation are to be promoted in the future, it is necessary to establish a system to cooperate and exchange information with other farming corporate managers in the region along with a support system by related organizations. Without these systems, even large-scale farms will have difficulty surviving.

(2) Development of environmentally-sound dairy farming and support systems (multiple farming in individual farms and regions)

In addition to the above, there have been different types of approaches by promoting “my-pace dairy farming” implemented in areas including Konsen District, and low-input and grazing dairy farming implemented in areas including Tokachi District. There are several farms to seek a new way of multiple farming by introducing a circulation system within a farm. They aim for environmentally-sound dairy farming (low-input and sustainable dairy farming), which is considered to be a direction for the future and has already become generalized in Hokkaido. The concept of environmentally-sound dairy farming has been gradually formulated since the 1980s, when production adjustment started, and has been established as a new way of dairy farming management in Hokkaido around the late 1980s through the 1990s. This is a environment-friendly individual management based on resource recycling. In dairy farming, resource circulation from human beings to grass and to cows is the most efficient to generate full payback. Also, the mutual trust between men and cows is essential to improvement in farm management. It is the method characterized as circulation farming by Torizo Kurosawa, a founder of our university (Fig. 1). We cannot ignore such circulation in order to carry out farm operation. Each farm should select an appropriate management style and scale (the number of feeding animals) in consideration of conditions of natural surroundings, grass and cows. In any management system, the farm manager will be asked to place the highest priority on the environmental problem and change his/her way of think-

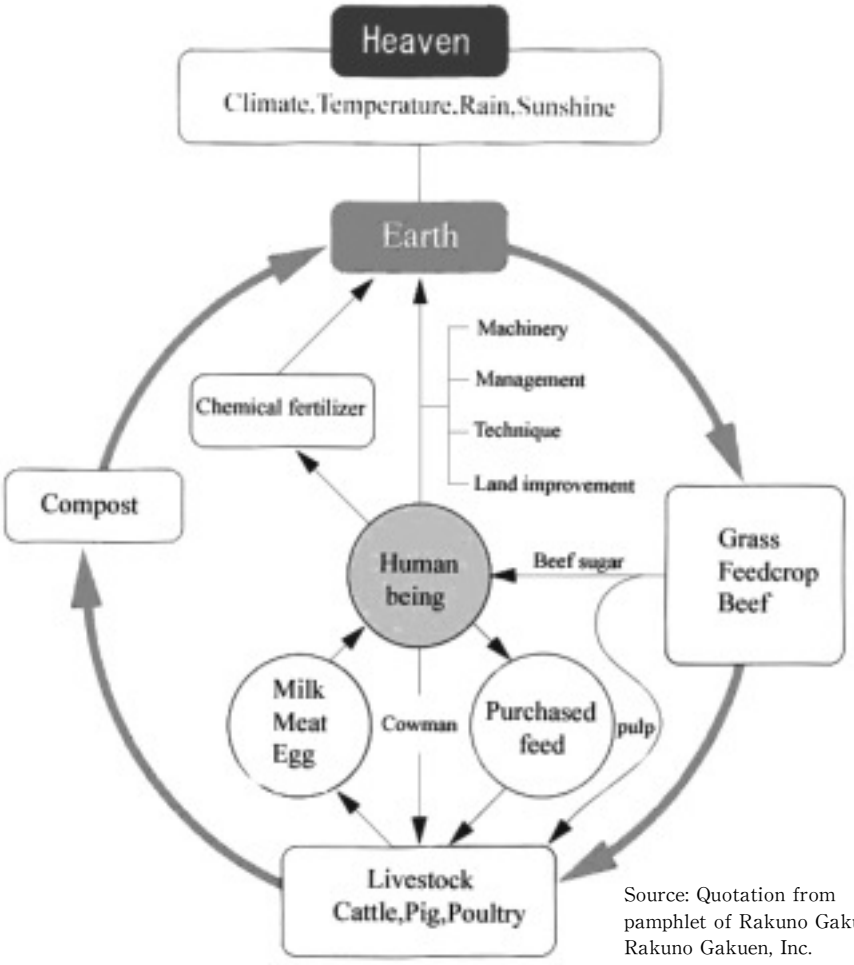


Figure 1 Sustainable Agriculture

ing about dairy farming from now on. Without a conceptual change, further development in dairy farming cannot be expected.

3. Circulation systems and conditions for sustainability in dairy farming and livestock raising

(1) Circulation system to sustain livestock industry, especially dairy farming

1) Background of establishment of a circulation system

Conventional dairy farming was based on circulating resources in the following order: soil, plants (grass) and residue, animals (cows), animal waste and manure compost, and soil. Within the soil, nutrients are circulated in the following order: soil, plants, animal, microorganisms, and soil. However, scale expansion of livestock farming (increase of feeding animals) has caused excessive byproducts, including massive animal waste that exceeds the limit of application to their own farm, which has made it difficult to keep the circulation. If the animal waste could be disposed of within a farm through being used (application) in the agricultural land, it would be unnecessary to establish a new circulation system. However, it has now become necessary for each farm to strengthen the collaboration with crop cultivation farms (cultivated land) in the neighborhood and establish a new circulation system to cope with the problem. The primary method is a circulation based on one-to-one correspondence between a dairy farm and a crop-cultivation farm. However, the number of feeding animals of one dairy farm has increased to the level at which the farm cannot manage its excreta alone since the late 1990s. So it became necessary to establish a system in which a dairy farmer collaborates

(exchange) with several upland cropping and paddy rice farms, as well as private distributors (organizations).

There are three steps of collaboration and exchange: the first step is that several upland cropping farmers supply (sell) wheat husks and straw to a dairy farm; the second step is that the dairy farmer supplies and sells manure (compost) as well as compost and digestive fluid after being extracted as biogas to the cropping farms and excessive waste is composted; and the third step is that the dairy farmer distributes or sells excessive compost to nonagricultural households and private organizations. This is an appropriate cycling system for animal waste and composted manure in rural areas (between farms). This system needs a certain number of dairy farms and crop cultivation farms in a neighboring area. Today's problem is that dairy farms and upland cropping farms do not exist in a neighboring area (1–5km) in Japan.

2) How to establish a circulation system

When there is no crop cultivation farm (that needs compost) corresponding to dairy farms in the neighborhood, they must establish a circulation system for circulation through distribution. The system makes it possible to sell compost to far-off crop cultivation farmers (actual users, such as horticulturalists).

When it is difficult for dairy farmers to find clients, they should commission a certain organization to take on such activities even if it is inefficient. The organization should be an agricultural cooperative.

They must build a compost center and joint compost barn in cooperation with agricultural cooperatives and other organizations to carry out sales activities and facility investment. This is because there is a limit to the financial power to build a treatment facility in each farm to produce high-quality compost. A distribution and sales network of compost should also be developed.

Here is a reason for the existence of distribution organizations and agricultural cooperatives. Today a distribution system using a joint compost burn and compost center (including the use of biogas) and distribution system are being established centering on dairy farming. This is what is needed for the dairy farming to survive in the future in which an individual waste cycling has become difficult.

(2) Formulation of a new cyclical use system, organizations to promote circulation, and their issues

1) Concepts of a cyclical use system and implementation methods

There is a need for the establishment of a cyclical use system from two aspects: One is cyclical use by crop cultivation farms and distribution organizations (private companies and hotel unions, etc.), and the other is from the viewpoint of land use (use of national land as farmland). There are problems, including the increase of idle land, which used to be farmland, and an increase in excessive reliance on feedstuff imported from overseas. If they could effectively use the land and imported feed, there may be a possibility of them solving their problems without heavy investments and constructing expensive facilities. However, even if we could establish such a system, it seems that the system would not be able to cover the entire area. In principle, animal waste (excreta) should be cycled within each farm. If this is impossible, the manure should be cycled jointly by several farms in the region. However, there is not enough farmland to make full use of manure and secure feedstuff at this point. Therefore, it is necessary to use unused land and community forests, and the use of unused land, including idle land, is not possible without the development of dairy farming. If two cows need 1 ha of grassland, a farm feeding 50 cows needs 25 ha grassland. In Japan, there are 1.765 million milk cows and 2.823 million beef cattle, which need 2.25 million ha of grassland. The area of grassland can be secured by fully utilizing agricultural land and other land (including community forests). This means that a cyclical use system of animal waste can be established by the effective use of existing land.

2) Issues concerning the establishment of a cyclical use system

There are some issues arising from the estab-

lishment of a cyclical use system, including the distribution and sales systems among several dairy farms, crop cultivation farms, and private companies. The most serious issue is that animal waste is not fully used as organic compost and its products cannot be properly sold due to the imbalance between demand and supply. As a result, only a portion of resources are implemented for cyclical use. The main body of cyclical use is comprised of farms or corporations with their own compost facilities, as well as compost centers, agricultural cooperatives, and third-sector companies (agricultural corporations and hotel unions). A cyclical use system cannot function smoothly on farms and related organizations alone; it needs administrative support (subsidies). In order to ensure a stably functioning system, it is necessary to include a cyclical use of daily-life-related organic refuse like food waste. This facilitates the participation of private companies (distributors) and support by governments and agricultural cooperatives.

4. Formulation of a biogas system as part of a cyclical use system and its issues

It is especially important that the biogas use system currently employed is used as an example of the processing / practical use methods of the feces and urine of a dairy because of the continuation of sustainable livestock production including dairy farming.[2] The practice of the Machimura pasture was considered as an introductory example to the individual dairy management object of this system.

That is to say that ideally there could be a self-support system which utilizes biogas made from cattle waste, especially the manure of digestive juices. Including construction costs, operation cost, etc. of about 470,000 yen per a cow even if it is the burden cost of the dairy management object of about 20,000 yen per animal per year, there is no income-and-outgo difference and "profits" can be added up rather than down.

The practical use of feces-and-urine on the farmland after biogas generating is required as a premise.

If these conditions exist, then the economic effects of the injection will be clear. To see practical examples aside from this one, observations of other farmlands such as Takachiho pasture etc. in prefectures can be made. (Fig. 2)

Moreover, regarding an example of a concentrated system, two superior models were examined to calculate the expense burden of an individual farmhouse, institution construction and management costs (Fig. 3)

Concerning the institutional costs of this example, each is a burden of national expenditure etc. and becomes a problem because of the financial stress from conveyance / spraying expense etc. that an individual farmhouse must pay (about 1.5 - 20,000 yen per a cow).

Unlike the individual example, expense starts conveyance, storage, spraying, etc. of feces and urine.

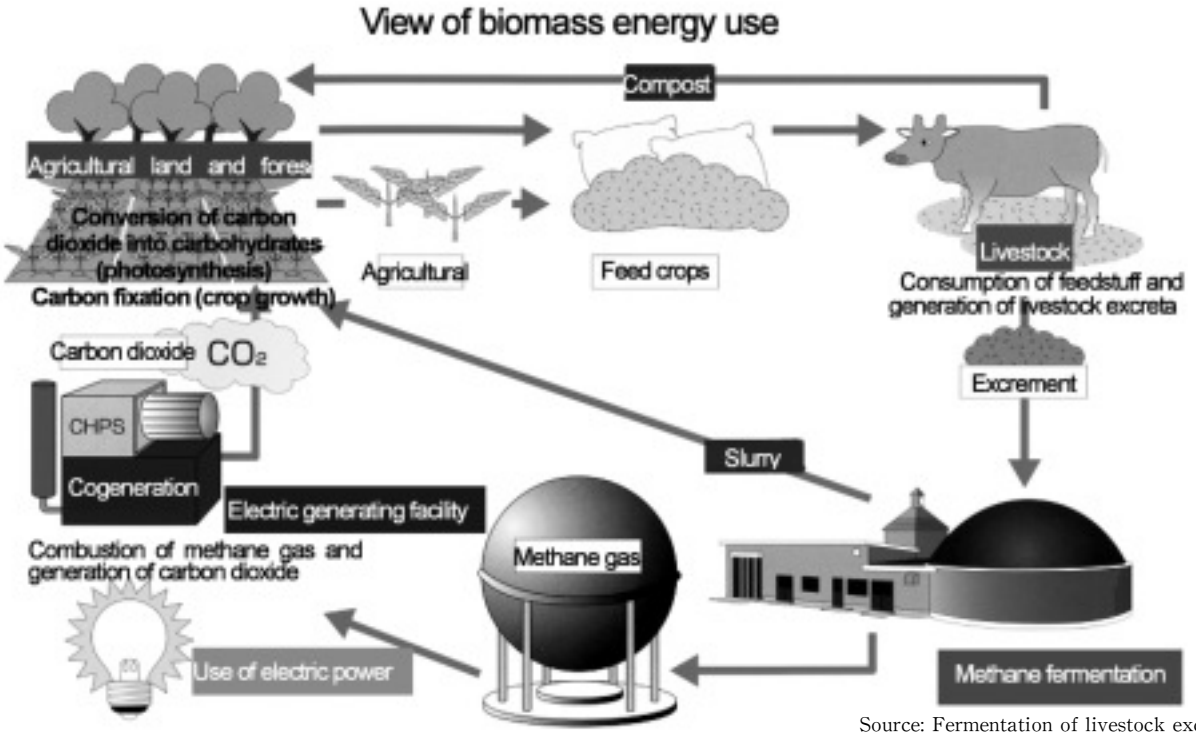
An institutional management subject pays it. Or meals will be provided according to profits gained from the exploitation of the generated gas energy, the profit of electricity sales towards utilities (self-support) and the sale of digestive juices. Profits can also be gained from surplus compost, liquefied fertilizer, and conveyance of spray to a farmhouse.

We think that the concerned parties of the organization need to acknowledge their insufficiency for the time being.

Anyways, at the present stage, in many examples construction costs and running costs, etc. far exceed the profits of energy exploitation from biogas production.

This problem is related to the administration of public subsidies support systems. It also encompasses the price of the generated electric power which is equal to the price of construction costs, and the computed use of biogas, and the quantity of gas, its heat use, the use problem of the digestive juices after fermentation, construction costs, etc.

In an individual model, if circulation management can be performed like the examples of Machimura pasture or the Takachiho pasture or enable payment at the expense of a town like Yagi-cho in a concentrated type, it may materialize in management as an economic target.



Source: Fermentation of livestock excreta and Generation of methane gas and carbon dioxide

Figure 2 Biomass System in Takachiho Farm

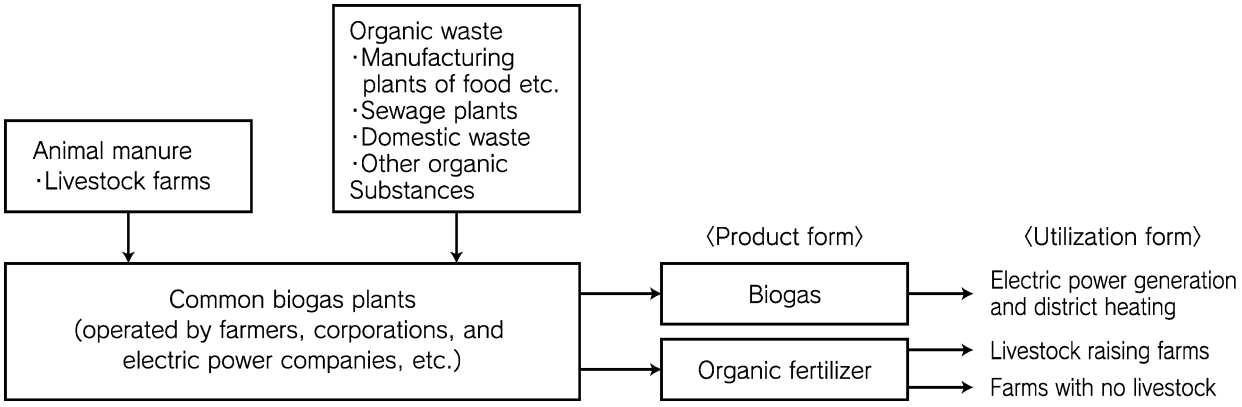


Figure 3 Key map of a common biogas plant

Source: "Practical use of the livestock feces and urine by a common biogas plant" by Hisamitsu Takai, p. 185, November 1995, a separate attachment of the Journal of Rakuno Gakuen University (vol. 20) titled "Research on the disposal of excreta and the practical use system in a dairy" edited by Osamu Ichikawa (representative researcher)

Thus, I think that one core of the resource circulation system of an area will be formed by forming a biogas system.

To sustain sustainable livestock production including dairy farming, it is important to establish a regional production system designed for sustainable livestock farming (Fig. 4). As part of the system, a biogas system has recently been adopted in dairy farming and livestock raising management. Though its testing stages revealed various problems, it is close to being put to practical use. A biogas system has two types, shared and individual. It was developed in Hokkaido, Japan. The establishment of such a system on a local level is one of the most important factors in developing a dairy and livestock production system. However, administrative bodies cannot sustain a biogas system because it is unprofitable.

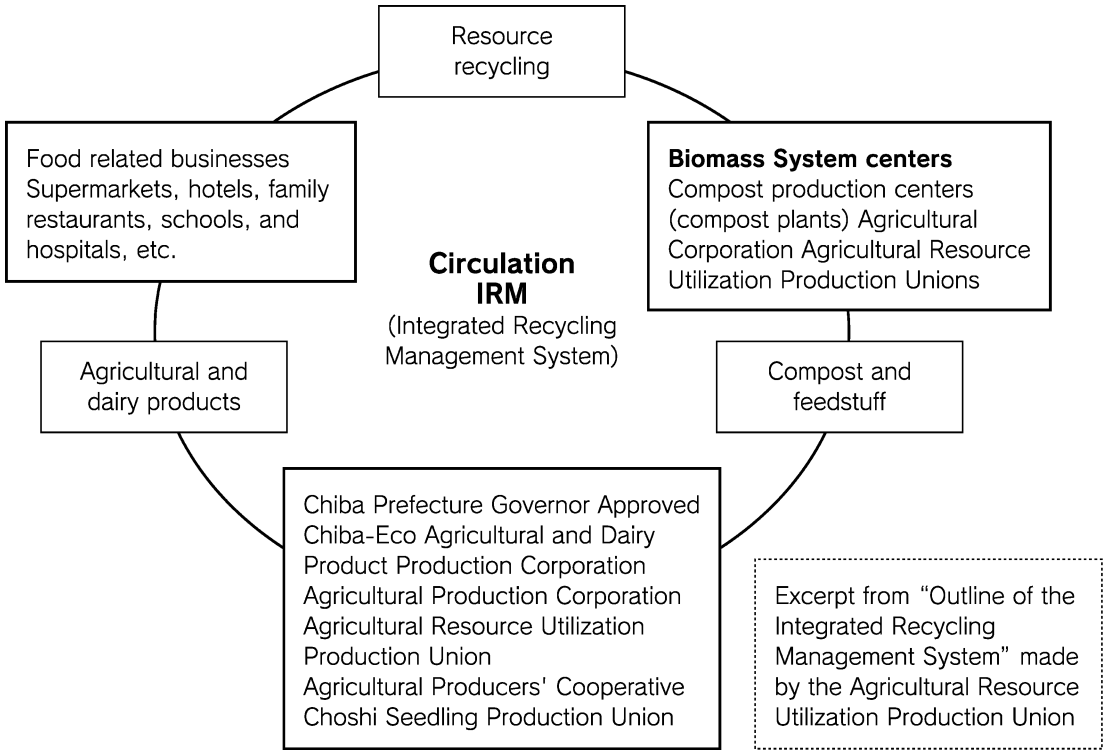


Figure 4 Integrated Recycling Management System for Material Circulation

There are still many problems, such as extremely high facility construction costs and operation costs, compared to that of the produced energy value.[3]

[Additional statement]

[1] This article is reproduced and partially reconstructed from our article "The conditions for development of sustainable livestock farming including dairy farming and its Issues" from the publication "The conditions for development of sustainable livestock farming including dairy farming" (published by the Association of Agriculture and Forestry Statistics in 2007: pp. 251–258). In addition, this manuscript reexamines the report in the JICA training work of the Obihiro University of Agriculture and Veterinary Medicine in the 2007 year, and corrects previous mistakes.

[2] The biogas system ferments excreta, and the subsequent thermal energy can be used for power generation and fuel using methane fermentation. Additionally, thermal energy can be added to reduce the production of CO_2 and its accompanying stink even though it resembles compost.

[3] Rustam Maimaiti has cooperated with preparation of this thesis.

要　　約

酪農・畜産の永続的な展開のために，様々な経営対応，経営展開の選択が必要とされる。今日，畜産，特に酪農経営の展開方向としては大きく三つの方向がある。ひとつは，従来の酪農経営の近代化路線ともいうべき飼養頭数等の規模拡大路線・高投入・高泌乳を追求するものであり，もうひとつは，飼養頭数規模はそれほどふやさず，現状維持を追求するものである。第三には飼養頭数はむしろ減らして，労働力条件，さらに生活条件に見あった「低投入」酪農ともいうべき方向・風土や自然条件，及び生活条件に対応する酪農経営，いわゆる「マイペース酪農」というものである。このように酪農経営の展開方向は多様な方向に進みつつある。このためのシステムの形成・展開が必要となる。

このような形成・展開を歴史的・要約的に検討し，新たな酪農経営展開方向を解明した。具体的には，酪農の飼養規模拡大・法人化が一方で進むなかで，

資源循環型酪農・畜産の形成・展開がもう一方で展開する。これらの酪農・畜産の持続的な展開にとっては循環システムの形成と支援システムが必要であることを明らかにし，そのシステム形成の方法を検討した。特に，この循環システムの形成にとってのバイオガスシステムの構築がひとつの重要な方法として今日登場してきており，この展開の可能性を検討した。これらの検討を踏まえて，資源環境型酪農・畜産が存続・展開していくためには，個別的な資源循環型の生産システムあるいは地域的な資源循環型の生産システムが形成されていることであり，それがまた，その条件でもあることを解明した。