발 간 등 록 번 호
11-1543000-004716-01

Joint Research for 2023 KAPEX with Mongolia

2024. 3.

Ministry of Food, Agriculture and Light Industry, Mongolia
Korea Rural Economic Institute, Republic of Korea

농림축산식품부

Yesun Erdene | CPPICD, Ministry of Agriculture, Food and Light Industry (MOFALI) | Director

Undrakh-Od Baatar | Technology Transfer Department, Mongolian University of Life Sciences | Soil specialist

Otgonbayar Norovsuren | Crop Protection and Agricultural Practices Team, MOFALI | Team Leader

Gochoosuren Sanjaa | MOFALI | Food and Agriculture Department Manager

Amarsanaa Bayar | Mongolian University of Life Sciences | Professor of Agricultural Science

Altanzaya Batsuuri | Bayanzurkh District Office | Professional Researcher

Jongsun Kim | Research Director | Korea Rural Economic Institute

Hyejin Jang | Researcher | Korea Rural Economic Institute

Changyong Kang | Senior Economist | Korea Rural Economic Institute

제 출 문

농림축산식품부 장관 귀하

이 보고서를「2023 국제농업협력(ODA) 정책컨설팅(KAPEX)」과제의 최종 보고서로 제출합니다.

2024년 3월

연 구 기 관: 한국농촌경제연구원
연구책임자: 차 원 규 (연 구 위 원)
연구참여자: 허 장 (명예선임연구위원)
김 종 선 (연 구 위 원)
김 경 필 (선임연구위원)
박 지 연 (연 구 위 원)
안 규 미 (전문연구원)
장 혜 진 (연 구 원)
주 영 선 (연 구 원)
이 진 성 (연 구 원)
전 민 경 (연 구 조 원)

Contents

List of Tables

Part 1

Part 2

Part 3

Part 4

List of Figures

Part 2

Part 3

1 Introduction

1. Research Background

In Mongolia, a traditional nomadic country, agriculture does not appear to have a large economic share, accounting for only 13% of GDP as of 2022, but it is an important industry as about 30% of the total working population is engaged in agriculture. In "Vision 2050," Mongolia's national long-term development strategy, agriculture is one of the main policy goals, including "4. Economic Development" and "8. Region-Centered Development." The Mongolian government has also established a step-by-step implementation strategy for agricultural development. In particular, Mongolia aims to implement sustainable agriculture that is eco-friendly and adaptable to climate change.

However, Mongolia is experiencing problems such as unstable crop productivity, agricultural land deterioration, and loss of land capacity. According to research results from The Research Institute of Plant and Agricultural Sciences in Mongolia, agricultural use of 347.0 ha of land between 2008 and 2018 was discontinued due to loss of fertility, erosion, and other factors. Meanwhile, the area of harvest land

(hayfield) and the number of livestock raised per unit area of pasture are increasing, leading to a decline in feed production capacity. Additionally, logging, inappropriate forest management, and climate change are accelerating the degradation of 47,000ha (0.4%) of forest area each year.

Meanwhile, Mongolia is very rich in organic waste resources, including recyclable bio-resources generated from paper and trees as well as livestock manure. The amount of livestock waste is 24.3 million tons per year (based on Hangai region, cattle, sheep, and goats), and organic waste amounts to 3.4 million tons per year. Accordingly, the Mongolian government intends to produce and use organic fertilizers by utilizing organic waste as a way to overcome instability in agricultural production, improve land quality, and prevent loss and erosion, but there is a lack of related systems, policies, and programs. , farmers are experiencing difficulties due to lack of awareness of fertilizer use and low demand.

Therefore, this research aims to analyze the overall fertilizer value chain, including the current status of Mongolia's fertilizer industry and organic waste management, organic fertilizer production capacity, fertilizer use status, and related laws, systems, and policies. It also provides implications and improvements through Korea's experience in organic fertilizer policy development.

2. Purpose of Joint Research

This study aims to propose a plan for fertilizer production and revitalization using organic waste in Mongolia. In particular, based on the case of Korea's fertilizer policy development, the study aims to draw policy implications for Mongolia and suggest ways to cooperate with Korea. The specific objectives of this study are as follows;

❍ Understanding the state of agriculture in Mongolia and the pressing issues of soil degradation, agricultural productivity, and more

❍ Analyze policies and issues related to soil conservation and improvement

❍ Analyze Korea's fertilizer industry and related policy developments and draw implications for Mongolia

❍ Propose Korea-Mongolia cooperation plan (ODA project) related to organic fertilizer

3. Joint Research Team and Methodology

3.1. Joint research team

The Korea Rural Economic Institute (KREI) and the Crop Production Policy Implementation and Coordination Department (CPPICD) of the Ministry of Food, Agriculture and Light Industry (MOFALI) in Mongolia formed a joint research team with expertise in fertilizer policies and systems, organic agriculture, soil analysis, and international development cooperation. The collaborative research was conducted from August 2023 to March 2024, and the tasks performed by the team were as follows.

〈Table 1-1〉 Korea-Mongolia joint research team

No	Full Name	Position	Affiliation	Research Tesk
1	Mr. Yesun Erdene	Director, CPPICD	MOFALI	Mongolia team leader
2	Ms. Undrakh-Od Batar	PhD, Soil specialist, Technology Transfer Department	Mongolian University of Life Sciences	• Analysis of soil and organic waste conditions in Mongolia • Discovery of ODA projects related to joint research
3	Mr. Otgonbayar Norovsuren	Team leader of the Fertilizer, Crop Protection and	MOFALI	• Analysis of Mongolian policies, systems, and strategies related to soil,

No	Full Name	Position	Affiliation	Research Tesk
		Agricultural Practices Team		organic waste, and fertilizer
4	Mr. Gochoosuren Sanjaa	Food and Agriculture Department Manager	MOFALI Ulaanbaatar Mayor city office	• Ulaanbaatar city organic waste management status, policy, and system analysis
5	Ms. Amarsanaa Bayar	Professor of Agricultural Science	Mongolian University of Life Sciences	• Analysis of research status related to soil and organic fertilizers in Mongolia, policy improvement suggestions
6	Ms. Altanzaya Batsuuri	Landscape Architecture and Civil Engineering Development Department Professional Researcher Bayanzurkh District Office	Bayanzurkh District Office	• Analysis of organic waste management status, fertilizer demand, etc. in the project site (Bayangzurkh district)
7	Mr. Jongsun Kim	Research Director, Center for International Agricultural Partnership (CIAP)	KREI	Korean team leader
8	Ms. Hyunjin An	Research Director, Office of Forest Economic Research	KREI	• Korea and Mongolia fertilizer market value chain analysis
9	Ms. Hyejin Jang	Researcher, CIAP	KREI	Research assistant
10	Mr. Changyong Kang	Senior Economist	KREI	Fertilizer Policy Expert in Republic of Korea

3.2. Methodology

3.2.1. Literature review

The joint research team conducted a literature review to first analyze the fertilizer market size, supply system, demand, and related policies and institutions in Korea and Mongolia. For basic statistics on the size of the fertilizer market in Mongolia, production value, and overall agricultural status, we used data from the Food and Agriculture Organization (FAO) and MOFALI's internal statistics. Fertilizer-related laws, policies, and institutions in each country were analyzed based on data from the Ministry of Agriculture and related government agencies.

3.2.2. Field Research

The Korean joint research team collaborated with the Mongolian joint research team to collect local information that is difficult to access through literature and to identify local fertilizer production and management system capabilities. MOFALI and the Institute of Plant and Agricultural Science (IPAS), Bayanzurkh District Office, fertilizer production companies, etc., which are candidate areas for the project, were visited, and interviews were conducted with each stakeholder. The field investigation took place from September 24 to 28, 2023, and involved three Korean joint investigators and one external expert in organic fertilizer production. The detailed schedule and tasks for the field investigation are as follows.

〈Table 1-2〉 2023 KAPEX Mongolia joint research field trip schedule and content

Date	Visiting Places	Main Contents
Day 1	Incheon → Ulaanbaatar	• Arrival in Mongolia
Day 2	Joint Research Kick-off Workshop (Ulaanbaatar)	• Conduct joint research kick-off workshop • Identify the status of organic waste and fertilizer management in Mongolia and analyze problems
	MOFALI Ulaanbaatar City Branch Food Waste Management Bureau	• Mongolian organic fertilizer value chain investigation and problem analysis • Monitor the current status of MOFALI organic fertilizer-related support projects and policies
Day 3	Indoor factory type fertilizer producer (Eco-Fertilizer)	• Identify Mongolian organic fertilizer production technology, analyze the current status and problems of the organic fertilizer industry • Interviews with organic fertilizer producers and data collection
	Institute of Plant and Agricultural Science (IPAS)	• Identify Mongolian soil analysis and management system and fertilizer-related research capabilities • Mongolian organic fertilizer production technology, related research status and problem analysis
Day 4	Open field fertilizer producer (Eco Taikhi)	• Identify Mongolian organic fertilizer production technology, analyze the current status and problems of the organic fertilizer industry • Interviews with organic fertilizer producers and data collection
	Bayanzurkh District Office (Project target site)	• Identification of organic waste management, fertilizer demand, business site suitability, etc. • Interview with greenhouse operation farmers and other stakeholders, collect local data
Day 5	Ulaanbaatar → Incheon	• Arrival in ROK

2 Mongolia's Fertilizer Market and Organic Fertilizer Supply Challenges

1. General Status of Agriculture in Mongolia

1.1. Agricultural Population

The total population of Mongolia is 3,398,336 as of 2022, and the population is small compared to the land area, resulting in the lowest population density in the world. The population growth rate was not significant from the 1990s to the late 2000s but has been increasing rapidly since 2010.

A characteristic of population movement is that, like other developing countries, a significant portion of the population, including the growing population, is migrating to urban areas. In the early 2000s, 40% of the total population lived in rural areas, but this number has decreased by 10% to 30% in 2021. In other words, the phenomenon of urban population concentration is slowly becoming apparent. In fact, the concentration of population around Ulaanbaatar is said to be causing important economic and social problems in Mongolia.[1)]

〈Table 2-1〉 Population change in Mongolia

Unit: 1,000 People

Content	2001	2006	2011	2016	2021
Population, total	2,472.60	2,581.24	2,743.94	3,029.56	3,347.78
Male	1,228.21	1,284.28	1,366.55	1,505.63	1,661.46
Female	1,244.39	1,296.96	1,377.39	1,523.92	1,686.32
Population, urban	1,408.84	1,625.24	1,876.80	2,067.61	2,236.32
Population, rural	1,010.94	932.77	884.71	959.79	1,014.83
Population, rural(%)	40.9	36.1	32.2	31.7	30.3

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).

The number of employee engaged in agriculture, forestry, and fisheries in Mongolia is gradually decreasing, below 300,000 as of 2021. Compared to the early 2000s, the number has decreased by about 150,000. In the process of reducing the number of employed individuals in the agriculture, forestry, and fisheries industries, the proportion of men has slightly increased, accounting for about 58% of the total.

〈Table 2-2〉 The Number of employee engaged in agriculture, forestry, and fisheries

Unit: 1,000 People

Year	Total	Male	Female	55~65 years old	65 years or older	Rate(%)	
						Male(%)	55 years or older(%)
2001	447.12	246.62	200.40	-	-	55.16	-
2006	418.26	231.12	187.12	-	-	55.26	-
2011	375.93	205.73	170.22	25.02	9.80	54.73	9.26
2016	351.57	201.07	150.60	35.84	10.10	57.19	13.07
2021	297.32	171.12	126.29	37.95	14.21	57.55	17.54

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).

Overall, the aging phenomenon of the agricultural, forestry, and fisheries workforce in Mongolia is relatively evident. The number of employed individuals over the age of 55 is also increasing, with the proportion rising by a significant 8.3 percentage points compared to 10 years ago, reaching 17.5% in 2021. In short, the employment of young people in the primary industry has decreased, while the employment of older individuals and their proportion in the total are increasing.

1) FAOSTAT (https://www.fao.org/home/en, Date: 2024.1.20.)

1.2. Agricultural Land

The total area of Mongolia is 156.4 million ha, and the land area is 155.8 million ha. Among the total land area, the agricultural area is 112.6 million ha, accounting for 72.3% of the total land area (2021, FAOSTAT). Vast pastures and rangelands (including forests) occupy most of the total agricultural land area, 98.8% (111.3 million ha).

Cropland cultivation area is estimated at 1.3 million ha (1.2% of the total). Most of the cultivated land does not have irrigation channels (93.5%). The organic farming area is very small, at 240ha.

As of 2021, grains are grown on 432,647ha, feed crops on 103,342ha, potatoes on 21,416ha, and vegetables on 11,220ha.[2] A two-part cultivation system in which spring wheat and fallow fields are grown alternately is common. If crop rotation and fallow land are insufficient, soil fertility continues to decrease, and soil degradation increases.

〈Table 2-3〉 Mongolia land use status

Unit: 1,000 ha

Content	2001	2006	2011	2016	2021
Land area, total	154,743.9	155,745.9	155,725.2	155,725.5	155,750.7
Agricultural area	130,129.5	114,727.3	114,187.8	113,560.8	112,631.2
Crop cultivation area	1,178.5	1,177.3	1,294.8	1,328.4	1,337.8
Permanent pasture, grassland	128,951.0	113,550.0	112,893.0	112,232.4	111,293.4
Irrigated cultivation area	88.5	91.0	94.0	88.0	87.4
Organic farming area	–	–	–	–	0.2

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).

[2] German – Mongolian cooperation project Sustainable agriculture (https://www.dmknl.de/de/projekthintergrund.html, date: 2024.1.20.)

1.3. Crop Production

Mongolia's main crops include wheat, potatoes, and oats, as well as carrots and cabbage. In recent years, there have been changes in the Mongolian people's eating habits. In response to this, items such as green garlic, tomatoes, cucumbers, and pickles are being introduced and expanded.

Based on the harvested area of agricultural products, the crop cultivated in the largest area is wheat, which is approximately 360,000ha in 2022. Next are potatoes (21,000ha) and oats (18,000ha). In addition, oats, grains, and barley, which are classified as grains, are grown and harvested in a relatively large area. In addition to food crops, carrots, turnips, and cabbage are harvested on approximately 7,000ha and 2,000ha, respectively.

〈Table 2-4〉 Harvested area by major crops

Unit: ha

No	Crops	2002	2007	2012	2017	2022
1	Wheat	208,644	116,651	297,318	270,989	357,950
2	Potato	10,233	11,462	16,821	13,052	21,015
3	Oats	2,800	1,214	3,324	3,982	18,403
4	Cereal	3,196	1,075	1,389	4,634	4,491
5	Barley	2,623	2,837	4,204	2,623	4,177
6	Carrot, turnip	1,200	1,923	2,452	4,201	7,477
7	Cabbage	2,000	1,185	1,230	1,029	1,819
8	Cucumber, pickle	190	223	367	355	721
9	Green garlic	-	-	-	-	356
10	Tomato	-	-	-	-	285

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).

Looking at the yearly change in crop harvest area, it is, in a word, very unstable. The variation in harvested area between years is quite severe. Various reasons appear to underlie this, presumed to be due to uncertainty in the process of collecting statistical data, changes in harvested area due to climate change, and

destabilization of production technology. This changing trend suggests that the stabilization of agricultural production and management in Mongolian agriculture is weak.

In terms of agricultural yields, food crops such as wheat and potatoes produce the most. They yield 400,000 tons and 210,000 tons per year, respectively (as of 2022). The overall production of grains is the largest, consistent with the area, estimated at about 630,000 tons per year. The remaining produce consists of vegetables (carrots, turnips, cabbage, cucumbers, etc), amounting to about 120,000 tons per year.

〈Table 2-5〉 Yield by major crops

Unit: ton

No	Crops	2002	2007	2012	2017	2022
1	Wheat	123,064	109,560	465,294	231,364	401,904
2	Potato	51,888	114,490	245,935	121,808	214,005
3	Carrot, turnip	7,500	22,536	32,755	38,263	71,519
4	Cabbage	10,500	20,563	20,248	15,214	36,952
5	Oats	1,100	1,020	5,934	3,495	20,334
6	Cucumber, pickle	3,200	2,881	3,668	3,922	7,003
7	Barley	1,797	3,908	5,925	1,694	4,126
8	Cereals	1,214	289	2,196	1,549	2,285
9	Green garlic	-	-	-	-	1,604
10	Tomato	-	-	-	-	2,196

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).

The annual production of agricultural products also fluctuates as much as the harvested area. It is presumed that this is also due to factors causing instability in the production of various agricultural products and agricultural management. Looking at production per unit area, which is one of the results, there is also a very significant difference from year to year.

Generally, in areas where staple crops are grown, only one crop is cultivated for a long time, resulting in relatively stable productivity. However, Mongolia's main grain crops appear to exhibit significant differences in productivity from year to year. For

example, in the case of wheat, production per hectare in 2012 was 1,565.0kg, but in 2017, it decreased by 45.4% to 853.8 kg. In 2022, it rebounded to 1,122.8kg. This pattern is also observed in vegetables. Considering this, the stabilization of agricultural production is judged to be one of the most important tasks for Mongolian agriculture.

〈Table 2-6〉 Production per hectare of major agricultural products

단위: kg/ha

Crops	2002	2007	2012	2017	2022
Barley	685.1	1,377.5	1,409.4	645.7	987.7
Cabbage	5,250.0	17,352.7	16,461.8	14,785.5	20,314.7
Carrot, turnip	6,250.0	11,719.2	13,358.5	9,108.1	9,565.3
Cereals	379.9	268.8	1,581.0	334.3	508.9
Cucumber, pickle	16,842.1	12,919.3	9,994.6	11,048.7	9,712.7
Oats	392.9	840.2	1,785.2	877.6	1,105.0
Potato	5,070.7	9,988.7	14,620.7	9,332.5	10,183.5
Wheat	589.8	939.2	1,565.0	853.8	1,122.8

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).

1.4. Livestock

It can be said that meat, obtained from livestock, is at the center of the traditional diet of Mongolia, which has historically led a nomadic life. Livestock have been raised using vast pastures, and the various agricultural and livestock products obtained from them have been consumed as important foods. Naturally, a large number of livestock have been raised.

Mongolia's five major livestock are sheep, goats, horses, cattle, and camels, but poultry farming has been increasing since the late 2010s. The introduction of feed crops and pasture management for intensive livestock farming is increasing. As of 2022, the number of major livestock raised is 73 million head, which is more than 2 head per person. Small and medium-sized livestock such as sheep, goats, and chickens number approximately 62 million head, accounting for 85.1% of the total.

The remaining are large livestock such as cattle, horses, and camels, which account for 14.9% of the total.[3)]

〈Table 2-7〉 Number of livestock in Mongolia as of the end of 2022

Unit: 1,000 heads

Livestock	Number	Livestock	Number
Sheep	32,748	Cow	5,513
Goat	27,569	Horse	4,821
Chicken	1,506	Camel (2019)	497
Pig	35	Donkey	0.05
Small and medium-sized livestock (subtotal)	61,858	Large-sized livestock (subtotal)	10,831
Total number of livestock raised		72,689	

Source: Author based on data from FAOSTAT(https://www.fao.org/home/en, date: 2024.1.20.), National Program for Soil Protection and Land Degradation Reduction" Mongolian Government Decision, No. 318, August 14, 2019.

〈Table 2-8〉 Changes in the number of major livestock farms in Mongolia

Unit: 1,000 heads

Year	Sheep	Goat	Cow	Horse	Chicken	Pig	Donkey
2002	11,937	9,591	2,069	2,191	61	18	0.80
2007	16,990	18,347	2,425	2,239	295	35	0.32
2012	18,141	17,558	2,584	2,330	469	40	0.20
2017	30,109	27,346	4,388	3,939	695	31	0.04
2022	32,747	27,569	5,512	4,821	1,506	34	0.05

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).

The number of livestock raised in Mongolia is increasing every year.[4)] In the case of sheep, which shows the largest number of sheep, there was a total increase of about 1.6 million, or 5.4%, between 2017 and 2022. Goats have also increased, and

3) National Program for Soil Protection and Land Degradation Reduction Mongolian Government Decision, No. 318, August 14, 2019

4) This increases the need to secure feed for breeding. At the same time, it implies that the possibility of encountering issues with the generation and disposal of livestock waste by the government is increasing. In particular, if the breeding method shifts from free-range farming to group farming, this issue will emerge as an important policy concern at the national level.

cattle and horses, which are large livestock, are also showing a steady increase. What seems special in recent years is the explosive increase in the breeding of broiler chickens and laying hens. In the case of chickens, the number of chickens raised has doubled over the past five years.

The production of major livestock products from farmed livestock is also increasing rapidly every year. Milk production is expected to soon reach 1 million tons per year. The amount of meat exceeds 550,000 tons, and various edible internal organs amount to 130,000 tons. With the increase in breeding of laying hens, egg production is also increasing very rapidly, showing an increase rate of more than twice that of the past five years. Leather production also reaches 120,000 tons.

〈Table 2-9〉 Changes in production of major livestock products in Mongolia

Unit: tons

Year	Raw milk	Meat	Edible intestines	Fats	Leathers	Wool	Eggs
2002	337,000	202,258	43,815	6,309	38,995	17,000	235
2007	414,100	188,376	43,482	5,954	39,390	18,200	2,587
2012	588,021	220,262	52,053	6,788	46,517	16,500	3,170
2017	919,497	354,766	84,048	11,422	77,763	15,179	4,828
2022	990,401	554,546	128,928	17,412	116,663	14,757	11,703

Source: FAOSTAT (https://www.fao.org/home/en, date: 2024.1.20.).
Note: In the case of raw milk, 2022 and 2007 buffalo are not included.

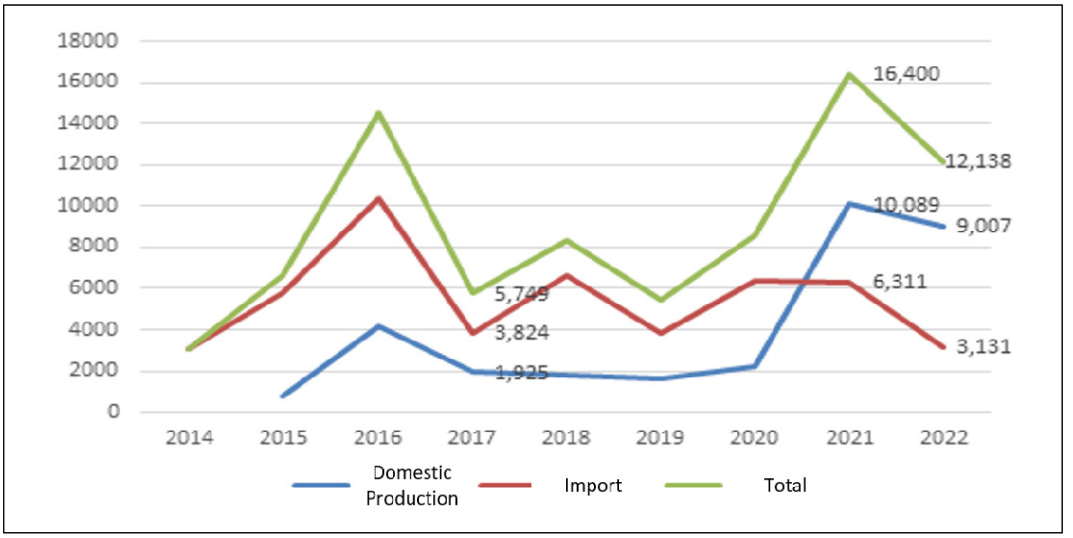
2. Fertilizer Market Analysis in Mongolia

2.1. Fertilizer production status

As of 2022, Mongolia's total fertilizer supply is only 12,000 tons. Looking at the past trend of total supply of fertilizers in Mongolia, it is not very stable. This means that although the size of the domestic fertilizer market is small, its size and demand also fluctuate greatly from year to year. The annual scale of domestic production is

also more unstable than that of overseas imports. In short, it is difficult to say that the fertilizer market in Mongolia is yet established.

〈Figure 2-1〉 Mongolian fertilizer production and import trends



Source: Undrakh-Od Baatar, "Current Status of the Fertilizer Industry and Policies in Mongolia", 「Start-up Workshop on the 2023 KAPEX Joint Research in Mongolia」, 2023. 9. 25.

Currently, Mongolia does not produce inorganic fertilizers, relying entirely on imports, and domestic production is limited to organic fertilizers. There are over 10 organic fertilizer production companies in Mongolia, such as Ekotaihi, Bio Undraga Shimtbor, Khan Deeji, Hiirev, and Eil BH Technology. These companies primarily manufacture organic fertilizers utilizing materials such as animal remains, excrement, inert substances, and dolomite, etc. The average annual fertilizer production from 2015 to 2020 was less than 2,000 tons, but appears to have increased more than five-fold to about 10,000 tons in 2021.

However, this is very insufficient to meet Mongolia's fertilizer demand. Based on IPAS (2010) data, considering Mongolia's significant agricultural and feed crop cultivation area spanning 560,000 hectares, an estimated annual requirement of approximately 300,000 tons of mineral fertilizers is projected.[5)]

At present, it is estimated that if organic fertilizer companies in Mongolia operate

at full capacity, they could meet 20% of the domestic fertilizer required amount. However, expanding production faces challenges due to low demand for fertilizer from Mongolian farmers. Accordingly, the import of fertilizers is being implemented as a public project by the government, and most of the fertilizers that are in short supply are imported from China. Farmers' limited awareness of the importance of fertilizers results in an insufficient effective demand for these products. This represents a significant barrier to enhancing the overall productivity of Mongolian agriculture.

〈Table 2-10〉 Fertilizer requirements for main crop production in Mongolia

Crops	Cultivated area (ha)	Input amount (kg/ha)			Fertilizer demand (1,000 tons)			Total requirement (1,000 tons)
		N	P	K	N	P	K	
Wheat	385,997	60	40	40	68.1	35.9	25.7	129.7
Potato	17,900	80	80	100	4.2	3.3	3.0	10.5
Vegetable	9,600	100	80	80	2.8	1.8	1.3	5.9
Fruit	4,300	120	90	90	1.5	0.9	0.6	3.0
Animal feed	66,500	60	40	40	11.7	6.2	4.4	22.3
Oil plant	40,000	90	60	60	10.6	5.6	4.0	20.2
유한지	360,250	60	40	40	63.6	33.5	24.0	121.1
Total	555,400				162.5	87.2	63.0	312.7

Source: Institute of Plant and Agricultural Science of the Darkhan-Uul Province. 2010.

Note: It is estimated that crops are actually grown on approximately 555,000 hectares, as some cultivation areas for each item are included in the limited land. When estimating the fertilizer amount, nitrogen content is assumed to be 34%, phosphoric acid is 43%, and potassium is 60%.

2.2. Fertilizer production Technology in Mongolia

Organic fertilizers in Mongolia are produced through the traditional method of composting organic waste by pulverizing it through aeration and supplying moisture. Thermophilic lactic acid bacteria decompose organic matter, and if

5) When referring to general chemical fertilizers, the actual demand by weight exceeds 600,000 tons.

fermented at 70℃ for more than 10 days, pathogens, weed seeds, pest eggs, larvae, and pests can be killed. This method takes 3 to 4 months to manufacture. When using specially developed thermophilic lactic acid bacteria, the fermentation period of organic resources can be shortened to 14 to 20 days.

Vermicomposting is also utilized. This method essentially employs various types of bugs to decompose organic resources and utilizes the resulting product as fertilizer. In the case of Mongolia, red earthworms are employed to obtain organic fertilizer. It is commonly referred to as earthworm castings (vermicast) and is recognized as a nutrient-rich organic fertilizer or soil conditioner.

2.3. Organic Fertilizer Producer Case Study[6)]

The joint research team visited major organic fertilizer production companies in Mongolia and investigated the overall organic fertilizer value chain, including production, distribution, and sales. Representative companies by production method were visited and interviewed, and the results are as follows.

2.3.1. Mongolian Eco-Fertilizer LLC

Eco-Fertilizer LLC is located in Bayanchadmany District, Tov Province. The headquarters is an indoor fertilizer production plant, and Chinese facilities and equipment were purchased through a Mongolian government project in 2013. The production facility is divided into stirring, fermentation, and processing facilities. The size of the stirring facility is 20m The processing capacity per day is 250 tons (based on 10 hours), and it is said that up to 40,000 to 50,000 tons can be produced

6) This section is written based on the contents of the joint investigation team field investigation report.

per year (excluding weekends). However, fermentation does not occur in winter due to low temperatures, so it is only operated from February to July. Currently, the demand for fertilizer is not large, so only about 600 tons are produced annually.

Raw materials are sourced from nearby group chicken farms, livestock farms, and nomadic households. In the case of group farms or nomads, livestock waste disposal is regulated, so fertilizer companies provide it free of charge as long as they pay the transportation cost. It is said that the secondary materials used are sand, wood, and sawdust. Incoming livestock meal is first fermented in a stirring facility for 30 days and then moved to a secondary processing facility. It was judged that there were no major problems in terms of production technology, considering that the original plate that made the granules was used during processing and that the drying and sterilization facilities for the produced granules were equipped in a batch system.

〈Figure 2-2〉 Indoor fertilizer production plant (Mongolian Eco-Fertilizer LLC)

Wide agitator view

Product processing system equipment

The product is mixed with fermented compost, packaged, and sold for 0.6 to 0.8 USD per 5kg. Previously, it was exported to China and Russia but has now been discontinued. Company managers expect to increase profits by expanding the government's organic fertilizer supply business in the future.

2.3.2. ECO TAIHI

ECO TAIHI is an open field fertilizer production company located in SDH 20th District, Ulaanbaatar. The average number of employees is 7, and excluding one person in charge of the fermentation site, 5 to 6 people are permanently and temporarily employed in fermentation and product packaging. This production company is a new company, and after pilot production of fertilizer in 2020, it passed the final government test in 2023 and began production and sales. The open land currently in use is government leased land, and ownership issues must be resolved.

They use raw materials, including livestock slaughter by-products (e.g. larynx and internal organs), livestock excrement, and waste. The firm pay an intermediate collection company to provide raw materials from nearby intensive livestock farms, so there are no raw material supply costs. Additionally, nearby farms also provide by-products and livestock meal. Sawdust is mainly used as an auxiliary material, and lactic acid bacteria are imported from Hokkaido and used as a fermentation accelerator. Sawdust was purchased from a wood factory for about 6 USD per ton. 5 tons of lactic acid bacteria are imported and used for 8 million tugriks, and are sold to other factories at a retail price of 14 million tugriks. It is said that 100 tons of the main raw material, 5 tons of lactic acid bacteria, and 55 tons of sawdust are inputted and fermented at one time.

Sawdust is mainly used as an auxiliary material, and lactic acid bacteria are imported from Hokkaido and used as a fermentation accelerator. Sawdust was purchased from a wood factory for about 6 USD per ton. 5 tons of lactic acid bacteria are imported and used for 2,400 USD, and are sold to other factories at a retail price of 4,200 USD. It is said that 100 tons of the main raw material, 5 tons of lactic acid bacteria, and 55 tons of sawdust are inputted and fermented at one time. During the fermentation process, the same amount of water as sawdust was required, but since there was no water supply facility, it was supplied from a nearby well.

When fertilizer is produced in the open field, it is transported to a processing

company and packaged and sold in units ranging from 1kg to 500kg. The company's fertilizer uses a lot of animal by-products, so most of its phosphorus and potassium content is purchased from greenhouse growers such as potatoes and sweet potatoes, or from seedling companies. However, as the demand for fertilizer was still not large, the amount produced was far below the fertilizer production capacity.

〈Table 2-11〉 Organic fertilizer sales price (ECO TAIHI)

Unit	Wholesale price (USD)	Retail price (USD)
1kg	1.04	1.5
11kg	4.5	6
100kg	240	297

Meanwhile, the government was requesting that waste from three slaughterhouses that slaughter 160,000 dogs in the metropolitan area be processed at a by-product fertilizer plant. In addition, a 30% price subsidy is provided to farmers when they purchase by-product fertilizers, and company managers expect fertilizer sales to increase as this business expands.

〈Figure 2-3〉 Indoor fertilizer production plant (ECO TAIHI)

The sight of fermentation in the open field

Fertilizer products for evaluation

2.4. Organic Waste in Mongolia

As Mongolia has a large livestock industry, organic waste is generated on a large scale. There is no statistical data on organic waste generated in Mongolia, but in 2018, the Mongolian Environment and Tourism Office conducted a survey on the structure and amount of household waste in Ulaanbaatar with support from the UN and Germany. According to this, the total amount of organic waste in Mongolia's central landfill in 2018 was 3.353 million tons, of which 1.394 million tons, or about 42%, was found to be generated in Ulaanbaatar city. The remaining 54.8% (1.96 million tons) was waste generated from rural areas. It was found that household waste being transported to the central landfill is increasing by approximately 282,000 tons every year.

The amount of organic waste generated among household waste is 1.777 million tons per year, accounting for 53% of the total. This is presumed to be due to the small proportion of industrial products such as construction waste and furniture among Mongolia's daily necessities, resulting in a relatively small amount of industrial waste. Most of the organic waste is food waste, accounting for 24% of the total waste and approximately half of the organic waste (45.3%). The second largest waste is paper, accounting for approximately 19% of total waste and 36% of organic waste. However, as urban population concentration accelerates in the future, the proportion of chemical and industrial waste is expected to gradually increase.

〈Table 2-12〉 Amount of organic waste generated from household waste in Mongolia in 2018

Unit: ton, %

Type	Amount	Total waste (%)	Organic waste (%)
Total, national	3,353,548	100.0	-
Total, Organic waste	1,777,380	53.0	100.0
Food waste	804,852	24.0	45.3
Paper	630,467	18.8	35.5
Trees	67,071	2.0	3.8
Green waste	167,677	5.0	9.4
Fibers and fabrics	107,314	3.2	6.0

Source: Undrakh-Od Baatar, "Current Status of the Fertilizer Industry and Policies in Mongolia", 「Start-up Workshop on the 2023 Kapex Joint Research in Mongolia」, 2020. 9. 25.

As of 2018, approximately 310,000 tons of organic resources, including animal waste, are generated in Ulaanbaatar, of which approximately 20% are recycled.

〈Table 2-13〉 Amount of organic waste generated from household waste in Mongolia in 2018

Unit: ton, %

Type of waste	Amount	Recycled	Rate of Recycle (%)
Construction, glass waste	319,945.5	36,176.0	11.3
Plastics	69,044.8	42,292.0	61.3
Organic waste	305,028.3	60,806.0	19.9
Metal waste and colored metals	134,145.3	119,388.0	89.0
Paper and cardboard waste	104,650.7	14,527.0	13.9
Animal waste	7,248.2	3,561.0	49.1
Hazardous waste, tires, batteries, automobile oil, etc.	8,647.9	1,749.2	20.2
Others	485,720.5	65,903.8	13.6
Total	1,433,431.0	344,403.0	24.0

Source: Undrakh-Od Baatar, "Current Status of the Fertilizer Industry and Policies in Mongolia", 「Start-up Workshop on the 2023 Kapex Joint Research in Mongolia」, 2020. 9. 25.

In fact, Mongolia still has the majority of nomadic agriculture, so it is very difficult to estimate the amount of livestock manure. In addition, livestock waste generated from grazing is used as fuel or is naturally decomposed, so it is returned to nature and does not cause problems. However, in cases where a large amount of livestock waste is generated in a small area due to group farming, livestock waste estimation is necessary for environmental management.

For example, the Khangai region in Mongolia is a mountainous area where livestock are raised relatively collectively. Approximately 2.2 million cattle and 31 million sheep and goats are raised in the Khangai region. The amount of livestock waste (cattle) and dry waste (sheep and goat) generated from these was estimated on the basis of 180 days per year.[7)]

7) The 180 days assumed in the estimate can be seen as a period of group rearing (in shelter) in a certain location, and at this time, livestock waste is intensively generated. Of course, since the rest of the period is spent grazing, it is assumed that there will be no waste problem.

The amount of organic waste resources generated throughout the Khangai region amounts to approximately 24.3 million tons per year. This figure excludes the number of chickens among various types of poultry, which is 1.32 million, from which 126,000 tons of feces are produced annually. In total, it is estimated that more than 25 million tons of livestock waste will be generated annually.

〈Table 2-14〉 Amount of organic livestock waste generated in Khangai region

Livestock	Head	Waste amount (ton)	Amount, Total (ton)
Cattle	2,200,000	4.0	8,800,000
sheep, goat	31,000,000	0.5	15,500,000
Total	33,200,000	4.5	24,300,000

Source: Undrakh-Od Baatar, "Current Status of the Fertilizer Industry and Policies in Mongolia", 「Start-up Workshop on the 2023 Kapex Joint Research in Mongolia」, 2020. 9. 25.

Overall, the amount of organic bio-resources generated in Mongolia is estimated to be enormous. Considering the amount of organic waste resources in Ulaanbaatar and Hangai regions presented above, it is estimated to be close to 30 million tons per year. This is because there is a large amount of organic livestock waste generated not only from daily organic waste but also from large-scale livestock farming. Therefore, it would be very beneficial to the country if they were used as raw materials for organic fertilizer production and the produced fertilizers were used to improve agricultural productivity. Of course, advantages can be secured in terms of farm unit, region, environment, and resource recycling.

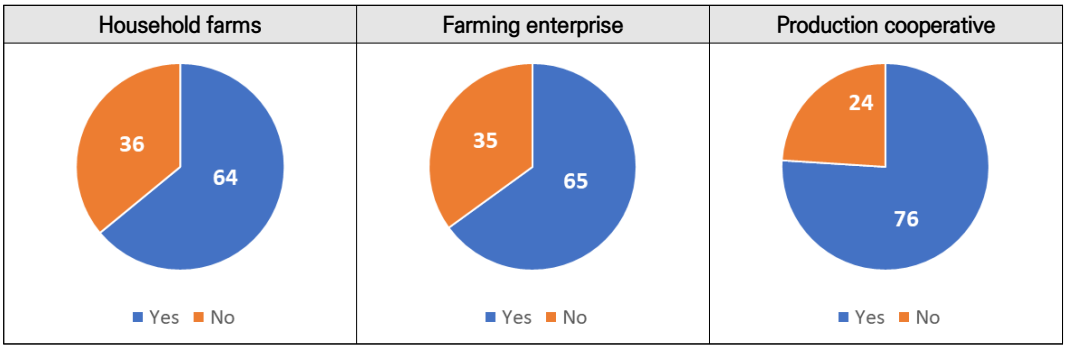
2.5. Fertilizer Demand in Mongolia

The German Ministry of Food and Agriculture and the Mongolian Ministry of Food, Agriculture and Light Industry (MOFALI) have been implementing the "German-Mongolian Sustainable Agriculture Cooperation Project"[8] since 2013. As a result of

surveying Mongolian farmers about their awareness, demand, and accessibility to agricultural materials through this project, Mongolian farmers responded that it is generally difficult to purchase fertilizers and pesticides necessary for agriculture. The exact reason is unknown, but it is presumed that we are in a situation where it is difficult to easily purchase and use the material in terms of basic awareness of the material, information, purchase place, ease of purchase, price, and purchasing ability.

〈Figure 2-4〉 Results of a survey on difficulties faced by Mongolian farmers in purchasing agricultural materials

Unit: %



Source: "Risk management in Mongolian vegetable production -opportunities and challenges", 「German – Mongolian Cooperation Project Sustainable Agriculture」, 2020. 10.

Many Mongolian farmers were aware of the characteristics of their soil. If they have been using the same farmland for a long time, they will naturally know about the soil quality of the farmland farmers are using. Nevertheless, about 20% of farmers were not fully aware of it. It is said that the government is conducting soil quality tests on major farmlands using a certain method. In this case, only 44% of farmers receive help from experts, and the remaining 56% do not receive advice on specific

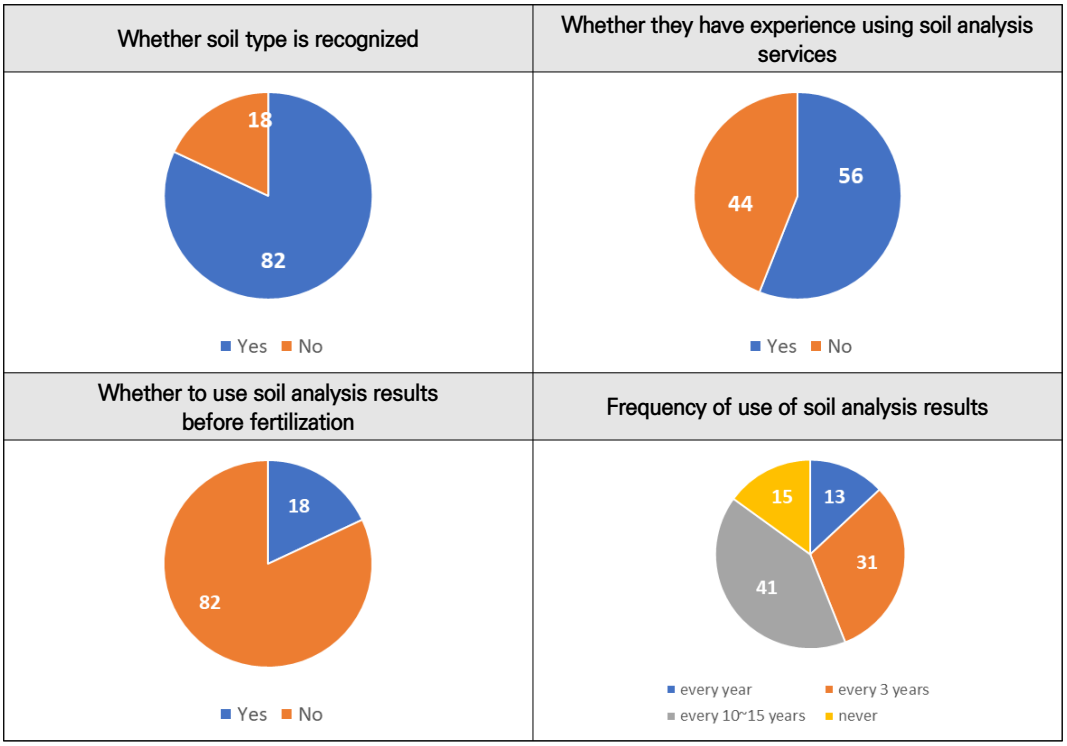
8) The German-Mongolian cooperation project Sustainable Agriculture between Germany and Mongolia is an instrument for the bi-national technical and political exchange of experiences, perspectives and policies in the context of the transformation towards resilient, sustainable food system. (https://www.dmknl.de/de/startseite.html. Date: 2024.02.10.)

methods. This ultimately creates a greater potential for incongruity of results, which can interfere with rational decision-making.

When farmers use fertilizers to pave farmland, 82% of responses to the question of whether they use soil analysis results for the land in question are negative, and the frequency of use is also very low. Intuitively, this means that farmers do not have much interest in and room for improvement regarding their soil. The intention to actively participate in the government's soil analysis and improve fertilization methods using the results to increase productivity appears to be insufficient. Of course, there will be various factors involved, but the simplest factor can be seen as determining that there is no benefit from such decisions and actions.

〈Figure 2-5〉 Opinions on the use of government soil analysis services

Unit: %

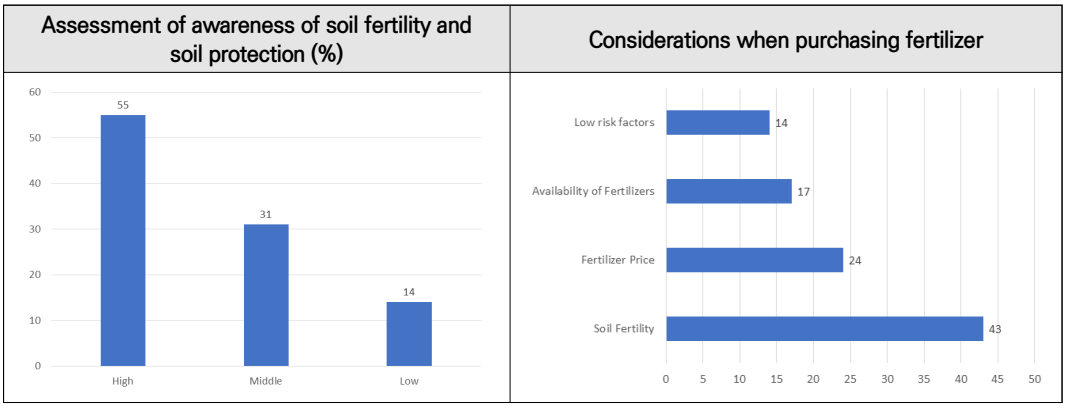


Source: "Market Study Part 1: Demand and Usage of Agrochemicals in Mongolia (Fertilizers and Pesticides)", 「German – Mongolian Cooperation Project Sustainable Agriculture」, 2016. 10.

Meanwhile, what farmers most considered when purchasing fertilizer was the condition of the soil (43%), and the second most important factor was the price of fertilizer (24%). Basically, Mongolian farmers must use fertilizers according to the condition and type of soil and there is a perception that fertilizers are important in agriculture. Therefore, if there are supporting factors that encourage farmers to use fertilizers, it is expected that the demand for fertilizers will increase compared to the current level.

〈Figure 2-6〉 Mongolian farmers' soil awareness and factors to consider when purchasing fertilizers

Unit: %



Source: "Market Study Part 1: Demand and Usage of Agrochemicals in Mongolia (Fertilizers and Pesticides)", 「German – Mongolian Cooperation Project Sustainable Agriculture」, 2016. 10.

Summarizing the situation of farmers regarding the purchase and use of fertilizers, farmers were aware of the need for soil management and fertilizer use to some extent, but in reality, their actions in response to the situation were insufficient. First of all, the economic and non-economic factors that can promote implementation and the parts that make them work can be seen as insufficient. First of all, it can be seen that government policies that ensure that farmers preserve the economic benefits of fertilizer use, as well as national management (soil analysis and compliance regulations, etc.)are necessary.

3. Fertilizer-related Laws, Policies, and Guidelines

3.1. Vision 2050

The Mongolian government is establishing and implementing a sub-development policy in accordance with "VISION 2050," Mongolia's long-term development policy announced in 2020. VISION 2050 has the top goal of becoming a leading country in Asia in terms of social development, economic growth, and quality of life for citizens, and presents nine goals in each field. Among these, "8. Regional-oriented development" has a detailed goal of achieving sustainable agriculture, and to achieve each goal, it is divided into three stages according to the period. The goals and detailed strategies for each period and stage are listed in the table below.

〈Table 2-15〉 Sustainable agriculture goals and practices

Goal	
Develop agriculture as a leading sector of the economy that is environmentally friendly, adaptable to climate change, resilient, responsive to social development trends, needs and requirements, responsible, highly productive and sustainable	
Stage 1(2021~2030)	
Goal	The period to intensify the resource utilization and commercialization of the agricultural production and transform the sector from quantity to productivity and quality.
Strategies	1. Adhere to the principles of green economy in agricultural production, strengthen capacity to adapt to climate changes and risks, and develop smart systems based on insurance, registration and information.
	2. Sustainably develop ecologically friendly and organic livestock while preserving the traditional nomadic heritage, diversify intensive agricultural production, and develop and improve cluster, logistics and leasing services
	3. Prepare and strengthen human resources in the agricultural sector, increase the value of their labor, ensure their stable employment, and improve their living conditions and social security.
	4. Evaluate, record, sustainably use and protect livestock genetic resources, improve livestock reproduction, breeding and selection, and transform livestock production from quantity to quality and productivity.
	5. Protect the livestock and animal health, meet hygiene and sanitation requirements of animal raw materials and products, protect the public health and promote free trade.
	6. Improve the utilization of the total crop rotation fields, ensure the main cultivated crops to fully meet domestic demand and increase the production of other functional crops.

	7. Develop specialized markets, supply chains and value chains for agricultural raw materials and products, and boost their economic potential and effectiveness.
	8. Provide sustainably the population with food supply from agricultural production and supply the processing industry with high-quality raw materials.
Stage 2 (2031~2041)	
Goal	The period to fully utilize agricultural resources and compete for sustainable production, efficiency and productivity.
Strategies	1. Develop agricultural production with a science-based, knowledge-based approach to sustainable development, develop knowledge as consumption, introduce advanced technologies and innovation, and strengthen cooperation.
	2. Establish quality evaluation for agricultural raw materials and products, strengthen the exchange trading system, and improve and expand the capacity utilization of resource-based processing plants.
	3. Expand foreign markets for agricultural raw materials and products, and reject imports and increase exports of some raw materials and products.
	4. Reform value chain financing and increase investment in agricultural production, increase exports of organic livestock products that contribute to the development of nomadic pastoralism around the world.
Stage 3 (2041~2050)	
Goal	The period to develop a "smart" agriculture.
Strategies	1. Support and develop science-based green production, business and agricultural tourism.
	2. Renovate the agricultural research and development system and expand biotechnology production aimed at full utilization of biological resources.
	3. Increase export through production of knowledge-infused, organic and branded products and create new sources of income in the economy.

Source: Mongolia Cabinet website (https://cabinet.gov.mn/, Date: 2024.2.21.).

Among the step-by-step agricultural development policies, the detailed implementation strategy proposed soil protection and fertility improvement and crop protection by producing and utilizing eco-friendly fertilizers as a strategy for agricultural equipment and products. In addition, a strategy was established to establish an effective standard management system for quality assurance and qualitative improvement of agricultural equipment and agricultural inputs.[9)]

9) Mongolia Cabinet website (https://cabinet.gov.mn/, Date: 2024.2.21.)

〈Table 2-16〉 Mongolian agricultural equipment development and development implementation strategy (2021-2030)

No.	Strategies
8.3.23	Fully introduce zero and downsizing technologies in crop production, promote the use of environmentally friendly fertilizers, and protect and improve soil fertility.
8.3.25	Grow and introduce new varieties of drought, disease and pest resistant crops, and fully meet domestic demand for seeds of certified varieties.
8.3.26	Improve the use of agricultural parks, domestically assemble some types of spare parts and equipment for the repair and maintenance of machinery and equipment, and introduce advanced irrigation techniques and technologies with low water consumption.
8.3.27	Implement comprehensive ecological friendly plant protection measures against the spread of diseases, weeds, pests and rodents of cultivated plants, and introduce good practices.
8.3.28	Establish an effective system for quality control and certification of agricultural raw materials and products, and improve the coordination of agricultural exchanges, national processing plants and suppliers.
8.3.29	Provide an investment and incentive support for concentrating and primary processing agricultural raw materials and products in accordance with the standards and supplying them to the market.
8.3.30	Fully utilize the capacity of processing plants in accordance with the resources of agricultural raw materials and products, and bring the level of processing of products to international standards.

Source: Mongolia Cabinet website (https://cabinet.gov.mn/, Date: 2024.2.21.).

3.2. State Policy on Food and Agriculture (2016-2025)

State Policy on Food and Agriculture (2016-2025) is a comprehensive, multi-sectoral document designed to guide nationwide efforts in enhancing food and agricultural production. Its primary objective is to bolster food security, recognizing it as a cornerstone of national security.

The Policy is guided by several key principles, including: (a) ensuring equitable access to nutritious and safe food for the population; (b) enhancing the capacity of human resources; (c) fostering research and development in agriculture and food processing; (d) fostering the development of value chains and enhancing competitiveness; (e) preserving and leveraging traditional knowledge in traditional pastoral animal husbandry; and (f) promoting the sustainable development of agricultural production by employing advanced technologies that are resilient to climate change.[10)]

Furthermore, the Mongolian government is preparing and implementing policies to achieve this goal.[11] In particular, the goal is to develop processed foods and industries related to livestock farming, with the promotion of production of milk, meat processing industry, and eggs being prominent.

The government is also planning to invest heavily in greenhouse projects to keep up with the increasing demand for high-quality vegetables resulting from rising incomes. In addition, the goal is to increase the vegetable production supply rate from the current 54% to 80% by 2027 by expanding the vegetable production base in rural areas.

3.2. Decision of the Great Khural of MU on several measures to be taken to ensure food supply and security

The Mongolian government has established various national programs to protect soil and reduce land degradation (Decision of the Great Khural of MU No. 318, 2019.8.14.). This program designates the responsible agency as the Minister of Environment and the Minister of Agriculture, and its main content is to invest approximately 3 billion Mt from 2021 to 2023 to increase fertilizer production to 90,000 tons by 2023.

"Resolution of the Great Khural of MU on several measures to be taken to ensure food supply and security" states: 1. Measures to reduce soil nutrient loss and improve

10) Mongolia Judiciary website (http://https://www.legalinfo.mn, date: 2024.02.21.)

11) "On some measures to ensure food supply and security" (Resolution No. 36 of the Greater Kural of Mongolia for 2022, "Four-year main directions for capital development from 2012 to 2025", Capital Citizens' Representative Assembly Resolution of February 9, 2020, "2020-2024 Action Program of the Capital Governor and Udubaatar Mayor", 2020 Capital City Citizens' Assembly Resolution No. 02/10, "Mongolian Government Activity Program 2020-2024", 2020 Mongolian Grand Kural Resolution No. 24 dated August 28, 2023, etc. Source: Capital Governor and Ulaanbaatar D, Symyaabazar Governor, "Documented Policy on Food Supply and Safety Guarantee," 2023, etc.

crop quality and production; The goals were set for the development of domestic fertilizer production, 2. import substitution and export support, and 3. the development of a technical and economic basis for the construction and equipment acquisition of nitrogen and phosphoric acid fertilizer plants based on the domestic mining industry.

In order to achieve the above goal, about 90,000 USD will be allocated to technology and economic development for research on raw material resources for nitrogen, phosphoric acid, and potassium fertilizers based on mine reserves in 2023 and the establishment of factories, 2. Preferential treatment from 2023 to 2026 planned to invest 4 million USD as a condition.

3.3. Fertilizer purchase price subsidy policy

MOFALI is planning a policy of subsidizing 30% of the price of fertilizers when purchasing fertilizers, regardless of domestic or foreign fertilizers, to protect soil and enhance crop growth. Farmers submit the results of the National Soil Testing Laboratory to fertilizer companies, and the fertilizer companies provide subsidies accordingly when providing fertilizer.

If fertilizer use is promoted through this system, it is expected to benefit both the government and farmers. Since the price of mineral fertilizer is 770 USD per ton, if 5,025 tons of fertilizer are supplied, the total cost is about 4.1 million USD, of which 30% is government funds, and about 1.2 million USD is government-supported incentives for this project. It is spent as If fertilizer is added in this way, production per hectare of wheat will be increased by more than 3 tons, and the total yield will exceed 1,670 tons per year. Therefore, excluding government costs, the net benefit is estimated to be approximately 530 million Mt.

〈Table 2-17〉 Estimated benefit from using 30% purchased supplemental fertilizer (wheat farmers)

Content	Unit	Value
Subsidy total	1 million MNT	3,920.00
Average fertilizer price per unit area	1 million MNT/ton	2.60
Total fertilizer amount	ton	5,025.00
Fertilizer usage	kg/ha	100.00
Fertilizer use area	ha	5,346.29
Average Wheat Production (2022)	dt/ha	12.50
Production increase per unit area of fertilizer use	dt/ha	3.13
Total production increase	tons	1,670.79
Wheat price per unit weight	tons/1,000MNT	900.00
Additional benefits from fertilizer use	1 million MNT	1,503.72
net profit	1 million MNT	529.30

Source: Undrakh-Od Baatar, "Current Status of the Fertilizer Industry and Policies in Mongolia", 「Start-up Workshop on the 2023 Kapex Joint Research in Mongolia」, 2020. 9. 25.

4. Necessity of Organic Fertilizer and Supply Challenges

4.1. Necessity of Organic Fertilizer

There are many benefits to circularly reusing organic waste resources, not only at the individual level but also at the national level. In other words, in Mongolia, where organic waste resources are abundant, establishing and using an appropriate recycling system can be beneficial in many ways.[12)]

First, recycling organic fertilizers can improve soil quality in Mongolia. Mongolia's agricultural soils are mostly light and silty, with a total organic matter content of 3 to 4% and a pH of 6.0 to 7.0, which is acidic to neutral. The organic matter content of Mongolian agricultural soil was found to be less than 2.5% in 70.7% (579.3 thousand

12) Undrakh-Od Baatar, "Current Status of the Fertilizer Industry and Policies in Mongolia", 「Start-up Workshop on the 2023 Kapex Joint Research in Mongolia」, added and organized focusing on the contents of September 25, 2020.

ha), and only 15.1% contained more than 3% organic matter. As a result, soil erosion is occurring at a serious level not only in farmland but also in pastures. However, when producing organic fertilizer and spraying it on land or forest areas, it naturally improves the structure and fertility of the soil and enhances the ease of absorption of fertilizer ingredients by crops, contributing to improving the productivity of agricultural products. Of course, spraying it on degraded pastures and forests will help restore soil and plant trees to improve productivity.

Second, it has preventive effects such as preventing soil erosion and groundwater contamination, and enhancing biodiversity. If organic fertilizers and resources are used on land and mountainous areas, soil erosion can be prevented in advance. It also plays a role in protecting groundwater by increasing the moisture content of land and mountainous areas and using organic fertilizers instead of chemical fertilizers. If organic agriculture, livestock farming, and forestry coexist, the extinction of threatened species will be prevented to some extent.

It can contribute to the circular economy and reduce greenhouse gases. Since organic resources are recycled in a circular system as much as possible, it is consistent with a future-oriented circular system economy. Within agriculture, an integrated system production structure of agriculture, livestock, and forestry can be established. In addition, as the introduction of external inputs, such as inorganic resources, is suppressed, greenhouse gas emissions are blocked to some extent. This is because the production of external inorganic resources requires the use of a lot of additional energy. In particular, in the case of inorganic fertilizer production, carbon emissions and energy use will increase.

In addition to these advantages, by producing and supplying safer agricultural products, consumers' trust in agricultural products can be increased. In the case of Mongolia, environmental protection (including odor) can be secured by reducing the increased livestock farming and the resulting disposal of environmentally harmful by-products. In other words, the disposal of large quantities of livestock waste generated from group farming is an important national problem, and the way to

solve this problem is to establish a structure to process organic waste resources in a circular manner, and the key is to return it to the place where it was generated. It is converted into fertilizer and returned to farmland, forests, and grasslands.

4.2. Organic Fertilizer Supply Challenges

However, there are challenges that the Mongolian government must solve in order to revitalize the supply of organic fertilizers. To summarize, it is as follows:.[13)]

① The fertilizer market in Mongolia is very small and many farmers are not using fertilizers, so it will be difficult for the market to expand in the near future. In addition, long-term demand forecasting is very difficult due to various reasons such as climate change.

② There is strong government regulation of the fertilizer market, including individual commercialization.

③ Illegal imports of Chinese products whose safety has not been verified are causing problems such as soil and environmental pollution and food safety.

④ The size of the wheat-centered fertilizer market is predominantly determined by the government's Agricultural Support Fund. Continuity and stable support are becoming important variables. Naturally, it appears that it is easy for large-scale companies linked to these funds to dominate the market.

In response to these various situations and problems, it is necessary to establish regulations related to the national market. Regulations related to corporate production and commercialization must also be changed to be more market-oriented. Of course, important considerations during this process will be the impact on plant growth and soil fertility, compliance with quality standards, and environmental impact.

---

13) "Market Study Part 2:Supply of Agro-Chemicals in Mongolia (Fertilizer and Pesticides)", 「German – Mongolian Cooperation Project Sustainable Agriculture」, 2016. 10

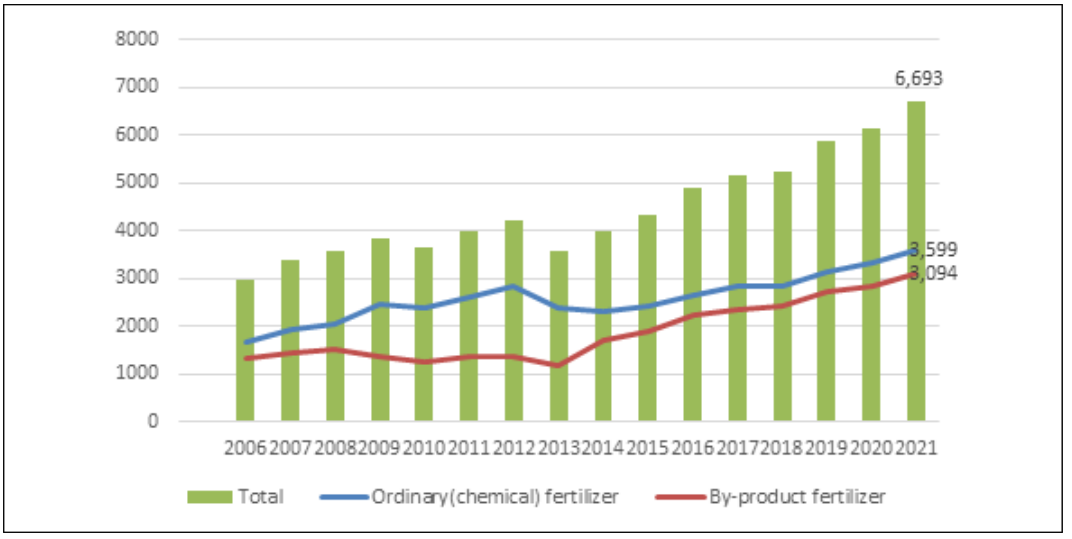
3 Korea's Fertilizer Market and Key Policies

1. Fertilizer Market Analysis in Korea

1.1. Fertilizer Market Size

There is a total of 6,693 fertilizer companies registered in Korea, including about 3,600 regular fertilizer (inorganic fertilizer) producers and about 3,100 by-product fertilizer producers. However, the number of companies that actually produce fertilizers and participate in the sales market is estimated to be about 10 for regular fertilizers and about 300 for by-product fertilizers. The number of types of regular fertilizers produced is 81, and the number of types of by-product fertilizers is 31.

〈Figure 3-1〉 Changes in the number of fertilizer companies in Korea



Source: Korea Fertilizer Association website (https://fert-kfia.or.kr/new/02_info/list.asp?code=bbs02_3, Date: 2024.2.21.).

As of 2020, the total size of the fertilizer market in Korea is approximately 1.4 trillion won, and is slightly decreasing compared to the past. Total sales of inorganic fertilizers are estimated at approximately KRW 578 billion, and sales of by-product fertilizers are estimated at KRW 850 billion (KRW 907.7 billion in 2015). Based on volume, the total shipment of ordinary fertilizers in 2021 is 2.32 million tons, of which 1.05 million tons are for agricultural use, and the rest is expected to be exported (excluding some stocks). Sales volume of by-product fertilizers is estimated at approximately 6.6 million tons.

〈Table 3-1〉 Korea agricultural fertilizer market size in 2020

Type	Amount(million $)	Quantity(million ton)
Ordinary(chemical) fertilizer	481.7	105(2021년)
By-product fertilizer	708.3	660(2015년)
Organic Materials	574.3	na
Total	1,764.3	765

Source: Korea Fertilizer Association website (https://fert-kfia.or.kr/new/02_info/list.asp?code=bbs02_3, Date: 2024.2.21.)
Note: 1,200 KRW=1$.

Shipments of agricultural inorganic fertilizers have steadily decreased due to the government's policy to reduce their use, but have plateaued since 2010, approaching the minimum amount. Currently, the amount used per unit area of agricultural land is also maintained at 260 to 280kg/ha, so it will not be easy to reduce it below that level. In addition, if the farmland utilization rate increases, the decrease in usage per unit area is expected to continue. Therefore, the size of the Korean fertilizer market is expected to remain the same.

1.2. Fertilizer Supply and Export

In the 1970s, Korea attained domestic self-sufficiency in inorganic fertilizers. Despite importing most of the raw materials, the domestic self-sufficiency rate for the final product, inorganic fertilizer, exceeds 100%, enabling an export capacity of approximately 1 to 1.3 million tons.

However, since the 2000s, the utilization rate of production facilities in the inorganic fertilizer industry has steadily declined from 80% to 60%. This decrease can be attributed to reduced consumption and sluggish exports. Due to the decrease in the agricultural cultivation area and the high-quality rice policy and policy to reduce the use of inorganic fertilizers since the 2000s, the amount used per hectare of farmland has decreased from 460kg in the 1990s to 286kg in 2021.

〈Table 3-2〉 Inorganic fertilizer supply and demand trends by year

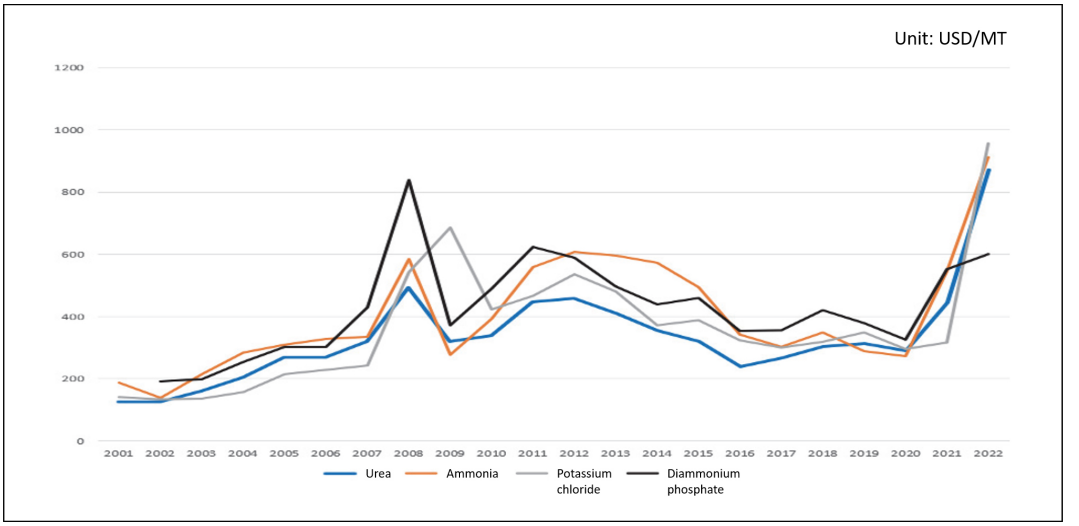
Unit: 1,000 ton, %

Year	Supply			Shipment			Stock
	Total	Product	Import	Total	Agriculture	Export	
2000	4,683	3,729	954	3,187	1,842	1,345	363
2005	5,303	3,950	1,353	3,414	1,935	1,479	631
2010	3,572	2,815	757	2,669	1,140	1,529	647
2015	2,742	1,982	760	1,875	1,184	691	390
2020	2,961	2,142	819	2,053	1,025	1,028	431
2021	3,046	2,287	759	2,320	1,046	1,274	325

Source: Korea Fertilizer Association website (https://fert-kfia.or.kr/new/02_info/list.asp?code=bbs02_3, Date: 2024.2.21.).

Korea relies on imports for most of the raw materials used to produce inorganic fertilizers. In particular, 100% of fertilizer raw materials such as urea, potassium chloride, and phosphate rock are imported. As a result, Korea's fertilizer market is very sensitive to international raw material prices. As a result, the Korean government is seeking temporary support measures to reduce the impact of fluctuations in fertilizer raw material prices.

〈Figure 3-2〉 Import price trends by inorganic fertilizer raw materials



Source: Korea Fertilizer Association website (https://fert-kfia.or.kr/new/02_info/list.asp?code=bbs02_3, Date: 2024.2.21.), requoted from Seo, et al(2022).

In the case of export fertilizers, before 2010, although the amount of profit was small, it played a role in reducing fixed costs by increasing the operation rate of fertilizer production plants. However, since 2010, the production costs of Korean fertilizer producers have increased due to the rise in fertilizer raw material prices and the entry of fertilizer raw material producers into the basic fertilizer market. At the same time, as international raw material prices rose and international fertilizer sales prices fell, the price competitiveness of the Korean fertilizer industry decreased. In the end, there were cases where the export price of finished products became lower than the price of imported raw materials.

The most important factor that led to this result is that Korean fertilizer production companies import most of the raw materials needed to produce inorganic fertilizers. As a result, the price competitiveness of the Korean fertilizer industry has declined since 2015.

〈Table 3-3〉 Comparison of fertilizer raw material import and export prices

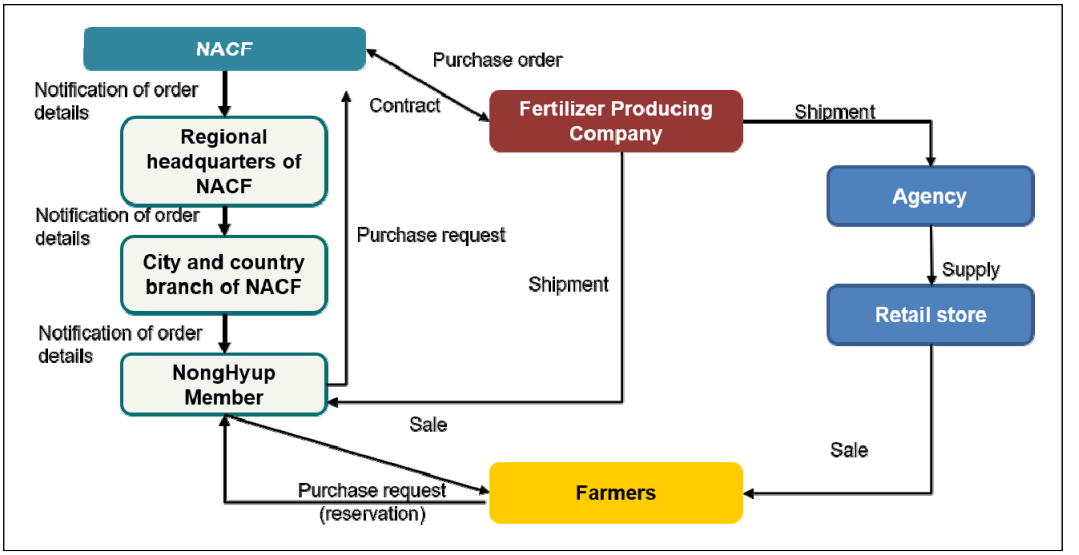
Content		2005	2010	2015	2020	2021
Export	Amount (1,000ton)	2,609	1,529	691	1,029	1,274
	Value (1,000$)	420,000	398,687	250,432	230,855	380,730
	Price per ton (a)	161	261	362	224	299
Import	Amount (1,000ton)	1,479	757	760	819	759
	Value (1,000$)	292,000	270,269	257,480	229,529	318,278
	Price per ton (b)	197	357	339	280	419
Price competition (b-a:$)		36	△96	24	△56	△120

Source: Korea Fertilizer Association website (https://fert-kfia.or.kr/new/02_info/list.asp?code=bbs02_3, Date: 2024.2.21.).

1.3. Distribution and Supply Structure

Inorganic fertilizers are supplied and distributed according to the systematic purchase of the National Agricultural Cooperative Federation. The National Agricultural Cooperative Federation establishes an annual fertilizer supply and demand plan by calculating the desired quantity of front-line unit cooperatives every year. This is a system in which an annual supply contract is concluded with a fertilizer producer through bidding or private contract for the quantity of fertilizer required for supply, and the supply is received from the fertilizer company and supplied to farmers.

〈Figure 3-3〉 Inorganic fertilizer supply structure



Source: Kihwan Park(2012).

The government delegates the operation of the fertilizer subsidy project to the National Agricultural Cooperative Federation. As a result, the National Agricultural Cooperative Federation exerts influence in the selection of fertilizers subject to subsidies and in determining the size of subsidies. In other words, it has resulted in a monopoly of demand by the National Agricultural Cooperative Federation in the fertilizer distribution market, and the Federation of National Agricultural Cooperatives occupies more than 99% of the distribution of general chemical fertilizers.

In addition, the National Agricultural Cooperative Federation has "Namhae Chemical," the largest fertilizer producer in Korea, as a subsidiary, so it plays an important role not only in the distribution but also in the production of fertilizers.

2. Soil Management System

In general, "fertilizer" refers to substances that bring about chemical changes in the soil in order to provide nutrients to plants or help grow plants, substances that provide nutrients to plants, and other materials for soil improvement. In Korea's *Fertilizer Control Act*, fertilizers are largely divided into "ordinary fertilizers" and "by-product fertilizers." Common fertilizers refer to chemical fertilizers. By-product fertilizers are manufactured using by-products from agriculture, forestry, livestock, fisheries, manufacturing or sales, human waste, food waste, soil microbial preparations (including soil enzyme preparations), soil activators, etc. It is defined as a fertilizer.

〈Table 3-4〉 Classification of fertilizers in Fertilizer Control Act

Classification		Ingredients and types
Ordinary fertilizer	Chemical fertilizer	nitrogenous fertilizers, phosphate fertilizers, potassium fertilizers
	Bed soil	bed soil no.1, bed soil no.2
Byproduct fertilizer	decaying organic matter	livestock manure, compost, decomposed bran, manure residue, etc
	organic substances	fish meal, bone meal, silkworm pupae meal, soybean meal, rapeseed oil meal, etc
	microbe	soil microbiological formulation (47 useful microorganisms)

Source: Korea Law Information Center website (https://www.law.go.kr/, date: 2024.2.11.).

Fertilizers are supplied to crops as nutrition or to improve and improve the soil, so investigation and analysis of soil conditions are important. This is because the growth of crops is determined by the nutrients and conditions in the soil. The results of such soil condition surveys become the most important nutritional information in determining the type and amount of fertilizer application to the land. Korea has been conducting soil survey since 1964, and the National Institute of Agricultural Sciences of the Rural Development Administration is in charge.

Soil survey is largely divided into seven stages and is currently in progress.

Currently, soil damage survey information obtained through soil surveys is publicly available on the Soil Information System (SIS), so anyone can find it.

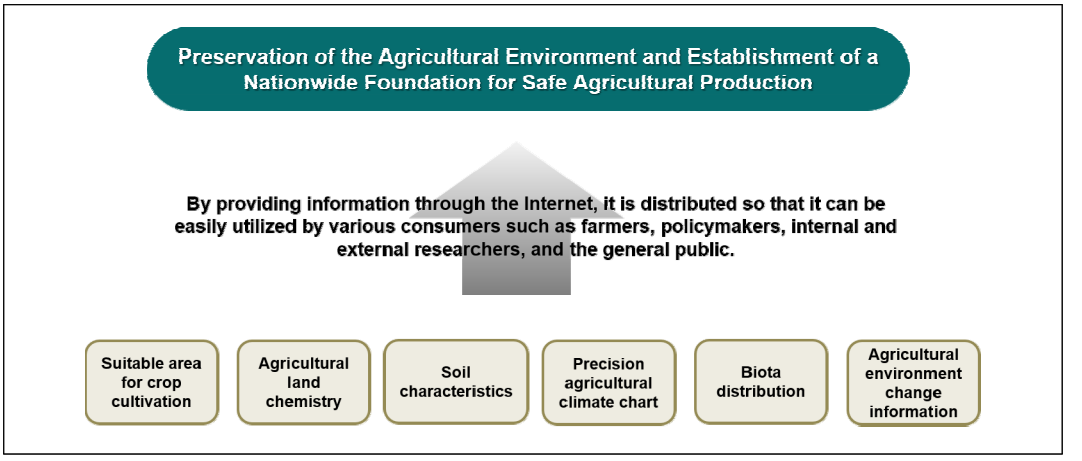
〈Table 3-5〉 Soil survey project history

Year	Soil survey projects	Applications
1964-1967	Reconnaissance Soil Survey (1:250,000; 1:50,000)	• Soil genesis and distribution of soil group • Central & regional land use planning
1968-1990	Detailed Soil Survey (1:25,000)	• Agricultural advice at regional and local level • Regional land use planning • Identification of major crop zone • Soil fertility management
1995-1999	Highly Detailed Soil survey (1:5,000)	• Individual household farm management • Soil management for individual plots • Choice of crop for individual plots • Selection of specific land management
1998-200	Digitization of soil Survey (soil map database)	• Crop & land use suitability recommendation
1998-present	Soil Testing Survey (soil fertility database)	• Fertilizer recommendation • Web-based fertilizer prescription
1999-present	Agro-Environmental Change Monitoring Project	• Managing soil resources: physical and chemical properties, water quality & soil microorganisms
2002-2006	Korean Soil Information System (1:5,000 digital soil map service)	• All soil information to the public through web
2009-2011	Web-GIS system for Agro-Environmental maps	• Spatial database on natural resources, 3-D soil maps, am image database, statistics & cyber forum

Source: SIS website (https://soil.rda.go.kr/soil/index.jsp, date: 2024.2.11.).

SIS provides information on soil suitability for each crop, farmland chemistry, soil characteristics, precision agricultural climate map, biota distribution, and agricultural environment change information through the Internet, enabling various users such as farmers, policymakers, internal and external researchers, and the general public to use the information. The goal is to disseminate it for easy use and establish a nationwide foundation for the preservation of the agricultural environment and safe production of agricultural products.

〈Figure 3-4〉 Purpose of SIS



Source: SIS website (https://soil.rda.go.kr/soil/index.jsp, date: 2024.2.11.).

It mainly provides information such as soil suitability for each crop, farmland chemistry, soil characteristics (30 types), precision agricultural climate map, biota distribution, agricultural environment change information, and eco-friendly certification for 66 crops (August 2023). In addition, prescriptions for fertilizer use, water use for field crops, and statistical data are provided, and an online inquiry and response service is also being implemented.

〈Table 3-6〉 Soil environment map construction and web service information provided by SIS

Soil environment map	Information provided
Soil compatibility by crop (64 crops)	• Apples, pears, tangerines, watermelon, grapes, strawberries, tomatoes, cucumbers, cabbage, etc.
Agricultural land chemistry	• pH, organic matter content, available phosphoric acid, potassium, calcium, available silicic acid, etc.
Soil characteristics (20 types)	• Morphological and physical characteristics, soil topography, soil classification, soil type, land use, etc.
Precision agriculture climate map	• Average annual temperature, highest temperature, lowest temperature, average monthly temperature, precipitation
Biota distribution map	• Vegetation, exotic weeds, aquatic insects
Agricultural environment change information (for business personnel)	• Farmland chemical properties, farmland physical properties, soil microorganisms, ecosystem biota, etc.
Soil test lot	• Tiled Map Service soil test, Dynamic soil test
Eco-friendly certification	• Organic products, pesticide-free agricultural products, complex (organic + pesticide-free agricultural products)

Source: SIS website (https://soil.rda.go.kr/soil/index.jsp, date: 2024.2.11.).

3. Main Policies of Inorganic Fertilizer

3.1. Inorganic Fertilizer Price Support Policy

The Korean government has implemented an inorganic fertilizer price preservation policy since 1962 to achieve self-sufficiency in rice. The core of this policy is to have the government sell fertilizer at a lower price than the purchase price and to support the difference. This policy was made possible by supplying inorganic fertilizers in bulk from Nonghyup as a government-commissioned project. It is evaluated that the effect of the policy has been an increase in fertilizer use by farmers, an increase in agricultural production, and a reduction in production costs.

This price support policy was abolished in 2005, but it was temporarily re-implemented when international raw material prices temporarily rose sharply and fertilizer prices had to be raised. However, all of these fertilizer price support policies were abolished in 2010.

〈Table 3-7〉 Summary of Korean fertilizer industry support policy

Year	Main policies	Activities	Corporate development direction
1962-1987	Fertilizer supplied by Nonghyup as a government-commissioned project	Sell at a price lower than the purchase price	Increased productivity
1988-1990	Changed to "Nonghyup material business" due to liberalization of fertilizer sales	Nonghyup exclusively supplies water fertilizer (supplying horticultural fertilizer since 1987)	
1991	In August 1990, due to the surge in raw materials due to the Gulf War, the "fertilizer sales price differential preservation system" was reintroduced	25% conservation every year	
2005	Chemical fertilizers become a reality by "abolishing the loss preservation system"	Excessive application of chemical fertilizers causes conflict with eco-friendly agricultural policies	Differentiated product development
2008	Temporarily introduced "chemical fertilizer price subsidy"	Subsidy amounted to KRW 62.1 billion in 2008 and KRW 236 billion in 2009.	Increased productivity

Year	Main policies	Activities	Corporate development direction
2010	Abolished "Chemical Fertilizer Price Subsidy" and introduced "Customized Fertilizer Subsidy"	Seed design considering city/county soil test progress and nutrient balance	
2011	Customized fertilizer and slow-release fertilizer semen assistance	Support for 30 types of customized fertilizers and 7 types of slow-acting fertilizers	
2012	Customized fertilizer subsidy (government KRW 20 billion, private subsidy KRW 30.2 billion)	-	
2013	Abolition of customized fertilizer subsidies	Decrease in custom fertilizer usage	

Source: Changyong Kang(2018).

3.2. Customized Fertilizer Price Support Policy

Customized fertilizer refers to fertilizer that mixes key ingredients to suit the soil environment and agriculture, taking soil test results and nutrient balance into consideration. Customized fertilizers have a lower content of general ingredients (nitrogen, phosphoric acid, potassium) than conventional fertilizers and are characterized as fertilizers that supplement trace elements that are lacking in the soil.

The government's price support for customized fertilizers was implemented as a complementary and environmentally friendly policy while completely banning price subsidies for inorganic fertilizers in 2010. There was also positive response from farmers as a policy that brought environmentally desirable results by reducing the amount of chemical fertilizers used and adjusting the content of ingredients according to soil conditions.

However, this price support policy, which had been in effect for four years, was abolished due to the fact that the target was inorganic fertilizers and the support of organic fertilizers used in eco-friendly agriculture was more important.

〈Table 3-8〉 Customized fertilizer support details

Unit	2010	2011	2012	2013	2014
Amount total (1,000ton)	927	940	934	830	820
Customized fertilizer (1,000ton)	498	533	506	387	350
Subsidy value (0.1 billion KRW)	731	366	200	100	abolition
Unit price (KRW/20kg)	1,800	1,100	800	(Cut)	-

Source: Changyong Kang(2018).

3.3. Inorganic Fertilizer Raw Material Purchase Fund Support and Tariff Allocation

For fertilizer production companies that import all of their inorganic fertilizer raw materials, the increase in international raw material prices is a very important management difficulty. The rise in international raw material prices acts as a factor in raising companies' operating costs and price increases.

Considering this, the government has been providing loans at low interest rates to inorganic fertilizer companies to purchase fertilizer raw materials since 2019 in response to price fluctuations in imported inorganic fertilizer raw materials in order to secure stable raw materials.

〈Table 3-9〉 Loan support for purchasing inorganic fertilizer raw materials

Unit: 0.1 billion KRW

Value	2017	2018	2019	2020	2021
Budget size	2,000	2,000	2,000	2,000	2,000
Allocation amount	1,845	1,966	1,839	1,946	1,820
Loan amount	1,441	1,661	1,341	1,411	1,598

Source: Korea Fertilizer Association website (https://fert-kfia.or.kr/new/02_info/list.asp?code=bbs02_3, Date: 2024.2.21.).

In addition, efforts are being made to reduce purchase costs by applying tariff quotas to imported inorganic fertilizer element raw materials. In other words, a

quota tariff on urea (1% until 2019, 0% thereafter) is being imposed to reduce the cost of importing urea raw materials and increase ease of procurement. The basic tax is 2% and there is no tariff (0%) for countries that have concluded an FTA.

3.4. Policy to reduce the use of inorganic fertilizers

In order to optimize the use of inorganic fertilizers worldwide and to respond to non-environmental factors in domestic agriculture, the Korean government has prepared a plan to reduce the amount of chemical fertilizers used, which reached the 470kg level in the mid-1990s, and has been promoting fertilizer reduction policies. The 5th Five-Year Eco-Friendly Agricultural Development Plan also plans to reduce it from ('20) 266 to ('25) 233kg/ha.

As a result of the government's policy implementation, the use of chemical fertilizers has decreased significantly, but recently the decline has plateaued at the 260kg/ha level. It appears that at least this amount of fertilizer is needed in the field.

4. Main Policies for Eco-Friendly Agriculture

4.1. Policy Establishment Background

Along with economic development, Korea went through a process of maximizing agricultural productivity between the 1960s and 1990s. Agriculture continued its rapid upward trend. However, in the process of rapid agricultural growth, various negative problems arose. Numerous water pollution and soil quality deterioration, including intensive livestock farming and the resulting inappropriate disposal of

livestock waste, damage to human livestock and the natural environment caused by increased use of chemical fertilizers and pesticides, loss of topsoil and solidification of farmland due to excessive use of agricultural machinery, etc. environmental problems, etc. occurred.

In response to the increase in agricultural productivity brought about by modern agriculture and the various problems that have arisen behind the increase in agricultural production, and as consumers' demand for stable agricultural products has decreased, the government is making efforts to transform modern agriculture into a new form of eco-friendly agriculture. will race.

Government organizations and related systems began to be established in the first half of the 1990s, and in 1994, the "Environmental Agriculture Department" within the Ministry of Agriculture and Forestry was established to oversee eco-friendly agricultural policies. In 1996, the blueprint for the development of eco-friendly agriculture, "Agriculture, Forestry and Fisheries Environmental Policy for the 21st Century," was established, and in 1997, the "Eco-Friendly Agriculture Promotion Act" was enacted. This law is now known as the Act on the Promotion of Eco-Friendly Farming and Fisheries and Management and Support of Organic Food, etc. (abbreviated as the Eco-Friendly Farming and Fisheries Act).

The meaning of eco-friendly farming and fishing is specified in related laws as follows.

"In order to promote biological diversity, promote biological circulation and activities in the soil, and preserve a healthy agricultural and fishing ecosystem, chemical materials such as synthetic pesticides, chemical fertilizers, antibiotics, and antibacterial agents are not used or the use is minimized. Refers to an industry that produces agricultural, marine, livestock, and forestry products (hereinafter referred to as "agricultural and marine products") in a healthy environment" (Article 2 of the Eco-Friendly Agriculture and Fisheries Act)

In addition, eco-friendly agricultural and marine products are organized into

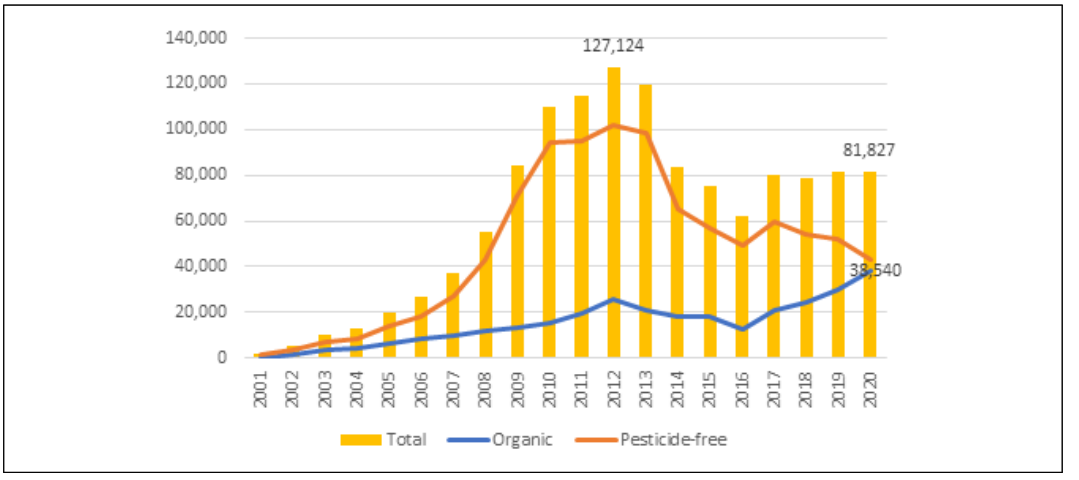
organic marine products, pesticide-free agricultural products, antibiotic-free marine products, and marine products without active treatment agents (hereinafter referred to as “antibiotic-free marine products, etc.”).

4.2. Development of Eco-Friendly Agriculture

The area of eco-friendly agriculture maintained a steady growth trend. The total cultivated area increased until 2012, reaching a record high of 127,000ha, then decreased, and has recently shown a plateau in growth at a certain level. In fact, until the 2000s, the area of eco-friendly cultivation increased rapidly based on active support from the government. At that time, because low-pesticide use was defined as eco-friendly agriculture, the area increased quickly. However, as this area was excluded from eco-friendly agriculture, there was a temporary decrease in area. Recently, the increase in area can be seen to have stagnated at around 5% (8.2 thousand ha) of the total agricultural area.

〈Figure 3-5〉 Changes in eco-friendly agricultural product certification area

Unit: ha

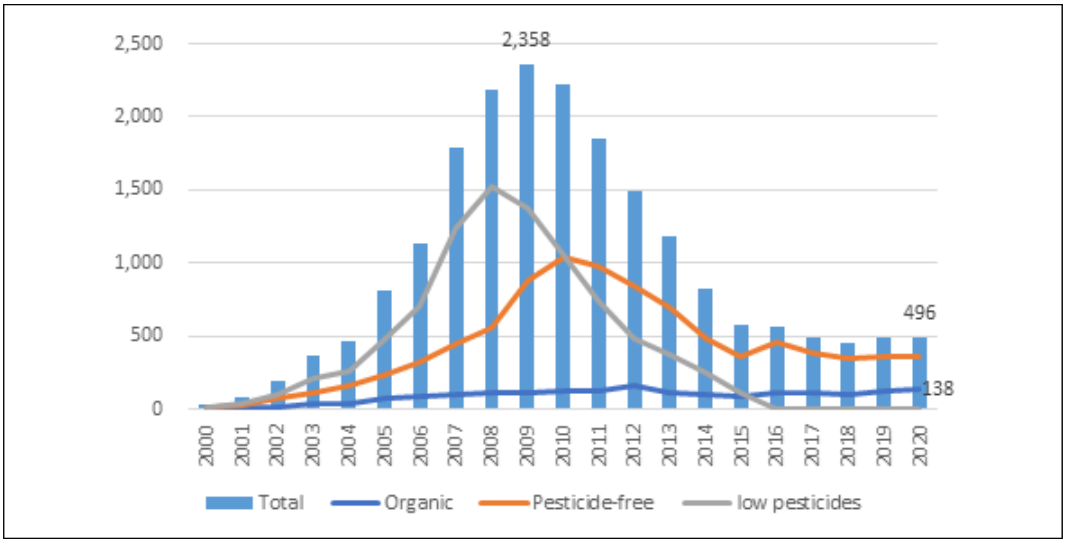


Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

The production of eco-friendly agricultural products also maintained a steady increase in the 2000s, but decreased after 2010. Recently, the growth rate has stagnated at about 500,000 tons per year. The annual production of eco-friendly agricultural products was approximately 2.3 million tons around 2010. At that time, the production of low-pesticide agricultural products amounted to 1.4 million tons, or about 58% of the total. However, as low-pesticide agricultural products have recently been excluded from the scope of eco-friendly agricultural products, production has continued to decrease. Over the past five years, production has been stable at a level of slightly less than 500,000 tons per year.

〈Figure 3-6〉 Trends in changes in production of eco-friendly agricultural products

Unit: 1,000 ton



Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

Despite the recent increase in the cultivation area and production of eco-friendly agricultural products, the prevailing expectation is that the overall market size for eco-friendly agricultural products will increase when looking at various future requirements. In 2016, the market distribution size of eco-friendly agricultural products was 1.4665 trillion won, and it is expected to increase by an annual average

of about 6% in the future. It is predicted that the market size will reach approximately 2.5 trillion won by 2025. Of course, this is a forecast that requires active government policy support.

〈Table 3-10〉 Market size estimation and forecast for eco-friendly agricultural products (2016-2025)

Unit: 0.1 billion KRW

Product	2016	2017	2018	2019	2020	2025
Cereals	5,217	7,508	7,863	8,218	8,573	10,352
Vegetable	3,617	4,700	4,785	4,871	4,956	5,382
Fruit	1,834	1,579	1,675	1,771	1,867	2,346
Root crops	607	875	909	943	976	1,145
Special crops/others	3,387	4,256	4,391	4,526	4,661	5,337
Total	14,665	18,918	19,624	20,329	21,034	24,563

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

4.3. Major Eco-friendly Programs

The most important system in establishing and implementing eco-friendly agricultural policies in Korea is the 『Eco-friendly Farming and Fishing Act』, and based on this law, the government establishes and utilizes a 5-year plan to promote eco-friendly agriculture every 5 years. This plan includes eco-friendly agricultural policy goals and basic directions, environmental pollution and improvement measures, and measures to reduce the use of chemical materials.

From 2001 to 2005, the 1st 5-year plan for eco-friendly agriculture development was established and has been continuously planned and implemented since then. Currently, the 5th 5-year plan for eco-friendly agriculture development (2021-2025) is being prepared and implemented.

The major projects implemented under the five-year plan are summarized as follows.

4.3.1. Eco-friendly/carbon-reduced agricultural infrastructure construction project

❍ Purpose: To promote the introduction of eco-friendly agriculture to strengthen agricultural environment management

❍ Carbon neutrality-related project goals

- Reduction in chemical fertilizer/pesticide usage (kg/ha): (2020) 266/10.5 → (2025) 233/9.5
- Construction of a festival circulation pilot district (openings): (2021) 3 → (2025) 15
- Establishment of city/county level agricultural environment conservation (practice) plans (number): (2020) 67 → (2025) 100

❍ Business goals related to eco-friendly agricultural production base

- Increase in eco-friendly agriculture certified area (%): (2020) 5.2 → (2025) 10
- Number of certified organic livestock farms: (2020) 104 → (2025) 16

4.3.2. Eco-friendly agricultural cluster development project

❍ Purpose: Carbon reduction by establishing a foundation for the expansion of eco-friendly agriculture, integration and scale of production, and further reducing production costs through this, etc.

- Development of eco-friendly agricultural clusters: (2025) 20% of eco-friendly cultivation area

❍ Content

- Support for facilities and equipment related to production, processing and distribution of eco-friendly agricultural products to producer groups.
- Support: Up to KRW 2 billion per location
- Support burden: 30% government subsidy, 50% local subsidy, 20% self-funded by the business operator

〈Table 3-11〉 Eco-friendly agricultural cluster district's step-by-step goals and support details

Cluster district	Goals and support details
Demonstration	• Goal: Promote expansion of cluster districts through eco-friendly farming of general farms. • Eco-friendly farming education and support for organic farming materials for general farmers, etc.
Basic	• Goal: Improve the competitiveness of the cluster district by improving productivity and improving distribution efficiency. • Support for farming groups, support for aerial pest control using organic agricultural materials, support for new and renewable energy facilities, support for distribution facilities and equipment, development and application of production cost reduction technology, support for strengthening the capabilities of the driving entity, etc. • The farming group is responsible for agricultural work agency, training for new entrants, and production management, focusing on young people in the cluster.
Leading	• Goal: Establishment of a production, distribution, and consumption system centered on clustered districts • Linkage support for organic industry complex service support complex, etc.

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

4.3.3. Eco-friendly agricultural direct payment system

❍ Purpose: Contribute to the spread of eco-friendly agriculture by compensating for the initial decrease in income and production cost difference of eco-friendly farms compared to general farms.

❍ Scale

- Payment limit per farm: 0.1~5.0ha
- Support: 100% paid by government treasury
- Target period: 5 years for organic produce, 3 years for pesticide-free produce

❍ 2023 budget: approximately 22.83 billion won

〈Table 3-12〉 Amount of direct payment

Unit: thousand won/ha

Field		organic	pesticide-free	organic(continuously)
paddy field		700	500	350
dry field	orchard	1,400	1,200	700
	others	1,300	1,100	650

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

5. Main Policies of Organic Fertilizer

5.1. Organic Fertilizer Price Support Project

In order to foster eco-friendly agriculture, the Korean government has gradually reduced and abolished the sales price loss compensation system (price subsidy) for inorganic fertilizers since October 2003. As one of its alternative eco-friendly promotion policies, a price subsidy project for by-product fertilizers has been implemented annually.

The price subsidy project for organic fertilizer was first implemented as a compost subsidy project by the National Agricultural Cooperative Federation in 1998, and the amount of subsidy at that time was a flat rate system. 1,000 won was provided per bag (25kg) of organic fertilizer. Currently, government support is differentiated by grade.

〈Table 3-13〉 By-product fertilizer support price in 2022

Unit: KRW/20㎏(bag)

Fertilizer type	Special grade	1st grade	2nd grad
Organic fertilizer		1,000	
By-product fertilizer	1,000	900	700

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

Note: Provinces and districts are obligated to pay a flat rate of 600 won per bag, and when preferential treatment is given to companies in the region, the unit price difference cannot exceed 300 won/20kg. In case of composted organic matter, it is prohibited to exceed 2 tons per unit.

The amount of government support increased to over 160 billion won per year, but has gradually decreased recently. As of 2022, it is approximately 110 billion won per year. Based on volume, it has been maintained at about 3 million tons per year, but recently this has also been around 2 million tons.

〈Table 3-14〉 Financial input for government-supported organic fertilizers by year

Unit: 1,000 ton, million KRW

Content	1999~2011	2012	2013	2014	2015	2016	2022(p)
Project volume	14,950	2,858	3,081	3,200	3,200	3,200	2260
National subsidy amount	712,550	143,441	161,327	160,000	160,000	160,000	113,000

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

5.2. Soil Improvement Support Project

The main purpose of this project is to improve the soil and maintain and preserve soil strength by supplying soil conditioners to agricultural lands with low effective silicic acid content and acidified soil, and has been implemented to date. Soil improvement agents are supplied every three years, and the volume increased to 800,000 tons per year in the 2000s. The average annual supply over the past five years is about 730,000 tons.

〈Table 3-15〉 Scale and quantity of government support for soil improvement products

Content	2005	2010	2020	2021	2022p
Quantity (1,000 tons)	637	820	458	427	404
Fund size (0,1 billion KRW)	398	874	838	716	763

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

As soil conditioners, Korea mainly supply calcareous fertilizers and siliceous fertilizers. The main purpose of lime fertilizer is to control pH and neutralize the soil to prevent acidification damage. Siliceous fertilizers are also aimed at soil improvement. In the case of siliceous fertilizers, the greater the amount used, the better, and it is evaluated that it continues to be effective for about 3 to 4 years. In other words, it was found that when 200kg/10ha is applied every year, the rice yield increases by 10%.

〈Table 3-16〉 Annual rice yield change after using siliceous fertilizer

Rice field type	Silicate application capacity (kg/10a)	1st year		2nd year		3rd year		4th year	
		Amount	Indices	Amount	Indices	Amount	Indices	Amount	Indices
Average	0	605	100	578	100	605	100	622	100
	228	652	108	615	106	620	102	625	100
	331	664	110	622	108	626	103	628	101
	494	682	113	632	109	634	105	638	102
	760	713	118	639	111	648	107	657	105

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

5.3. Support for Eco-friendly Compost Production Facility Modernization Project

Since 2013, funds have been provided to modernize eco-friendly compost production facilities. The purpose of this project is to support the renovation and repair of aging compost production facilities and to encourage safe agricultural production by establishing a production base for high-quality fertilizers and improving compost quality. The business scale per supported business office is approximately KRW 300 million, and the project started with a total annual project cost of KRW 9 billion. It has now decreased to 8.4 billion won, but continues.

〈Table 3-17〉 Eco-friendly compost production facility modernization fund support limit per location

Unit: KRW million/place

Unit	Government subsidy	Local government subsidy	Government loan	Self-pay
300 million KRW	60	60	90	90
(100%)	(20)	(20)	(30)	(30)

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

5.4. Organic Farming Material Support Project

Among various organic agricultural materials, the purpose is to reduce the burden of management costs and improve soil power by supporting eco-friendly farmers with the cost of purchasing green manure crop seeds and soil testing consulting costs. Furthermore, the purpose of the project is to implement sustainable agriculture by encouraging a reduction in the use of pesticides and chemical fertilizers.

Supported items include green manure crop seeds (hairy vetch, green manure green barley, rye, soybean sprouts, sudangrass), organic materials (raw materials), soil testing, and fertilization prescription consulting. Green manure seeds and organic farming materials are 20% supported by the central government and 30% by local governments, and soil testing, fertilization prescriptions, and consulting are 100% supported by the central government.

〈Table 3-18〉 Annual financial investment plan for organic farming material support project

Unit: million KRW

Support entity	2013	2014	2015	2016	2017	2023
Total	25,000	15,000	17,000	15,980	10,350	34,480
Central government	5,000	3,000	3,400	3,196	3,105	6,896
Local government	7,500	4,500	5,100	4,794	2,070	10,344
Self-pay	12,500	7,500	8,500	7,990	5,175	17,240

Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

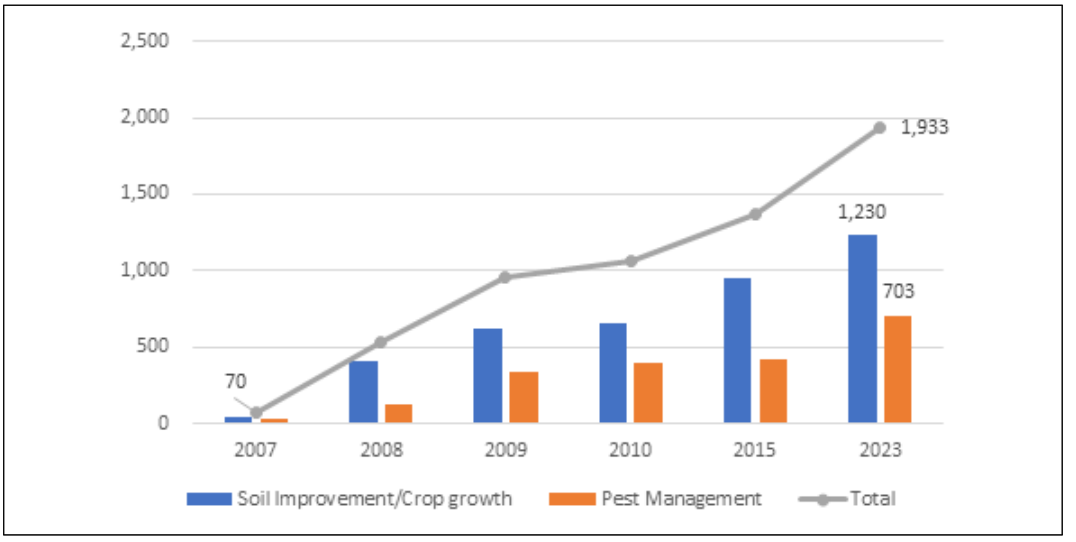
5.5. Organic Material List Disclosure System

When producing and selling eco-friendly agricultural materials, the suitability must be reviewed by the government and certified organizations before being announced. The government can provide policy support for organic materials

recognized through these procedures. Organic materials refer to products made using raw materials or ingredients that are permitted to be used in the process of producing, manufacturing, processing or handling organic products. The number of organic materials announced on the list is increasing every year and exceeds 1,900 as of 2023. Among these, 1,230 are related to soil and crop growth, which is almost twice as many as those related to pests and diseases (703).

〈Figure 3-7〉 Organic material disclosure and quality certification trends

Unit: Number



Source: National Agricultural Products Quality Management Service, eco-friendly certification statistics (http://www.enviagro.go.kr).

6. Livestock Waste Processing Support Project

Unlike eco-friendly agricultural policies, projects related to by-product processing are also being implemented in livestock sector policies. Most of these are policies necessary to properly dispose of livestock manure, and there is a total of eight representative policies.

6.1. Livestock Odor Improvement Project

The livestock odor improvement project is a project that aims to prevent environmental pollution and public inconvenience by appropriately treating livestock waste and reducing livestock odor by supporting equipment for livestock waste treatment and odor reduction facilities. Targets of support include livestock waste treatment facilities (composting/liquidization, purification treatment energy conversion facilities/equipment, etc), odor reduction facilities and equipment (biocurtain, fog spray facility, biofilter, etc), auxiliary machinery and equipment (loader, solid-liquid separator, compost/liquid manure transportation) vehicles, etc). The total project cost limit for each region (city, county, or district) is 3 billion won, with 20% supported by the central government and 20% by local governments, and the remaining 10% self-funded and 50% financed.

〈Table 3-19〉 Support limit per livestock odor improvement site

Unit: million KRW/ Place

Places	Pig	Cattle	Milk cow	Chicken	
				Plain yarn	Cage
Individual farm	500	300		200	
Clean livestock farm, environmentally friendly livestock farm	600	360		240	
Agricultural corporation	1,000	600		400	
Recycling report, compost/liquid fertilizer specialized distribution organization, etc.	200				

Source: Livestock Environmental Management Institute website (https://lemi.or.kr/).

6.2. Odor Measurement ICT Mechanical Equipment Support Project

The goal of this project, which supports odor measurement ICT machines and equipment, is to support effective odor reduction activities by collecting, analyzing, and providing real-time environmental odor information using equipment focusing

on areas in need of livestock odor improvement. The cost support for installing and managing odor measurement equipment is 20 million won per location, and the central government and local governments are sharing half of the cost (50% each).

6.3. Joint Resource Recycling Facility Village-type Compost Storage Facility Support Project

The primary purpose of this project is to solve the problem of shortage of compost for small-scale livestock farms by establishing facilities to store and manage compost at the village level. Furthermore, the goal is to contribute to revitalizing natural cycle agriculture and reducing greenhouse gases by enabling the production of high-quality livestock manure compost, solid fuel, or biochar.

The amount of project cost support per location is less than 1 billion won (new). In case of linkage with other businesses, it is limited to 700 million won. The project support period is 2 years, and the project cost composition is 40% national funds, 30% local funds, and 30% loans.

〈Table 3-20〉 Village-type compost storage facility support project business unit support scale

Unit: million KRW/ Place

Village type	Value		
	Compost storage facility	Compost production facility	
		solid fuel	biochar
New	300	400	700
Link	-	400	700

Source: Livestock Environmental Management Institute website (https://lemi.or.kr/).

6.4. Joint Resource Facility Renovation Support Project

The purpose of the project is to improve the treatment efficiency of the facility itself through renovation of the existing facility, as well as to reduce the odor caused by livestock manure, which is the most problematic issue. The support amount is divided into two types. First, in the case of facility expansion (facilities in operation for more than 3 years from the date of completion), support of up to 3 billion won per location is possible. Next is renovation (facilities in operation for more than 5 years from the date of completion), which is set at less than 1.5 billion won per facility. The support conditions are 40% government funding, 30% local funding, and 30% government financing.

6.5. Joint Resource Facility New business Support Project

The scale of support for new joint resource facilities projects is very large. The purpose of this project is to resolve the difficulties of processing livestock waste at the farm level, reduce greenhouse gases and promote natural circulation agriculture through resources such as compost and bioenergy using livestock waste.

This support project, which has a three-year project period, has different support scales depending on the type. First of all, the processing types are divided into four types, and the amount of support is determined differently for each location. It consists of a minimum of KRW 430 million per ton and a maximum of KRW 119 million per ton.

There are certain restrictive regulations depending on the business entity. First, in the case of the private type, the treatment standard of 70 tons per day is applied, and compost composting, bio-linkage (biogas, solid fuel and biochar, etc.), and energy conversion (including farm type) projects can be carried out. In the case of public-

type energy projects, the support limit is within 300 tons/day of facility capacity and the project cost is within 40 billion won.

〈Table 3-21〉 Support limit for new joint resource facility projects

Unit: million KRW/ ton

Processing type	Amount (ton/day)					
composting	70	64	56	51	47	43
Sediment and liquefaction	82	73	60	54	48	46
Bio-related	64	62	59	56	53	50
Energization	119	118	100	98	86	84

Source: Livestock Environmental Management Institute website (https://lemi.or.kr/).

Note: Project costs for capacity not presented are calculated using linear interpolation, rounded off to units below 1 million won (based on total project cost). For farm-type energy facilities, a unit price based on capacity of 70 tons/day is applied.

〈Table 3-22〉 Joint resource facility new project support ratio (%)

Type	Central government	Local government	Government loan	Self-pay	Loan conditions
Sediment and liquefaction	40	30	30	-	10 years (3-year grace period, 7-year flat repayment), 2.0% per year (3% for private companies, etc.)
Bio-related	40	30	30	-	
Energization (public type)	50	20	20	10	

Source: Livestock Environmental Management Institute website (https://lemi.or.kr/).

Note 1: Local expenses (city/provincial expenses, city/county expenses) burden ratios are organized in accordance with the "Rules on Standards for Expense Burden of Local Government Systems Pursuant to the Main Text of Article 33 (1) of the Enforcement Decree of the Local Finance Act".

Note 2: In the private type, when replacing local expenses with self-pay, up to 50% of the local expenses can be replaced. When replacing part of the local expenses, the project entity must present supporting documents as a result of consultation, such as a clear investment contract with the head of the local government (for the public type, all or part of the local expenses can be replaced) (can be replaced).

6.6. Livestock Manure Use Promotion Project

The livestock manure utilization promotion project is a project that supports farmers to use the by-product fertilizers produced well. In other words, the goal is to effectively return livestock manure compost and liquid manure to farmland to

strengthen agricultural rotation and revitalize agricultural growth. Furthermore, the purpose of this project is to promote the consumption and use of solid fuel and biochar by diversifying processing methods.

The business is largely divided into compost spraying, liquid fertilizer spraying, and others. Compost spreading is a project that supports the cost of compost spreading only when compost that meets the compostability standards is spread on a secured spread area and then entered into the livestock waste resource management system (Agrix). The cost of spraying liquid fertilizer is supported only when a fertilizer use prescription is issued, sprayed on a designated recycling lot, and entered into the Agrix system. The two project expenses are paid differentially according to the results of the inspection of the operation status of the livestock manure conversion organization, and for grade A, 300,000 won per ha, for grade B, 200,000 won, and for grade C, 100,000 won.

In addition to spraying, the project supports the cost of promoting the use of livestock manure for overseas export of treated solid fuel, biochar, and bioplastics, and 50,000 won per ton is paid only when distributors enter information such as consumption into Agrix.

The amount of funds supported by the government so far to promote the use of livestock waste was 40 billion won in 2008. Since then, the project cost has continued to increase, reaching a peak of approximately 108.6 billion won in 2020. In 2023, it decreased to 32 billion won.

〈Table 3-23〉 Amount of support for livestock waste use promotion project

Unit: ha, million KRW

Year		2008	2010	2015	2020	2021	2022	2023
Number of Project		40,000	49,000	65,680	108,600	92,000	46,000	32,000
Project budget	Total	6,000	9,800	13,136	20,720	18,400	9,200	6,400
	Central government	3,000	4,900	6,568	10,360	9,200	4,600	3,200
	Local government	3,000	4,900	6,568	10,360	9,200	4,600	3,200

Source: Agricultural and Forestry Business Information System, AgriX (https://uni.agrix.go.kr/webportal/main/portalIndex.do).

〈Table 3-24〉 2023 Livestock Manure Utilization Promotion Project Volume and Project Cost

Project type		Amount	Unit price	Project cost (million KRW)		
				Total	Central government	Local government
Budget	spraying	22,000ha	200,000KRW/ha	4,400	2,200	2,200
	others	40,000ton	50,000KRW/ton	2,000	1,000	1,000

Source: Agricultural and Forestry Business Information System, AgriX (https://uni.agrix.go.kr/webportal/main/portalIndex.do).

Note: provincial/district governors allocate spray volume (area) and production/distribution volume (ton) to each provincial/district depending on the sprayable area and processing capacity of the distribution entity.

6.7. Natural Cycle Agriculture Revitalization Support Project

The policy goal of this project set by the government is basically to recycle livestock waste into resources, return it to the soil, and strengthen natural circulation. Through this, the goal is to promote the production and supply of agricultural products and forage, and further realize a natural cycle agriculture in which cultivation and livestock farming coexist.

The project aims to provide funds necessary to promote the use of compost and liquid fertilizer to professional management companies that are promoting natural circulation agriculture. 70% is provided by the national treasury, and the remaining 30% is borne by the management companies.

The intended use of the support funds is as prepayment for the shipment of agricultural products and forage produced using compost and liquid fertilizer, or as securitized funds, as well as miscellaneous expenses related to the production and distribution of compost and liquid fertilizer (purchase of raw materials such as sawdust, farmland rent), and education/liquid fertilizer. It can be used as promotional expenses.

4 Conclusion

1. Conclusions and Recommendation

1.1. Enhancing the use of organic fertilizers to achieve Mongolian agricultural development goals

Mongolia was achieving self-sufficiency in basic agricultural and livestock products. However, there is a supply shortage in some agricultural products. The policy goal is to supply this shortfall. In addition, sufficient supply of processed foods, for which demand is increasing, is also seen as an important agricultural policy goal.

The production of some agricultural products and vegetables needs to be expanded, and the supply of various meats and dairy products must be increased. Efforts were being made to prepare and implement a plan for this purpose. In particular, the cultivation of glass greenhouses (approximately double the current supply rate, 20% supply rate) and the expansion of vegetable supply (54% in 2020 ⇨ 80% in 2027) are important agricultural policy goals.

〈Table 4-1〉 Summary of Mongolian agricultural development goals

Final Goal	Increasing the supply rate of agricultural and livestock products and processed foods

Midterm goal	1. Stable expansion of agricultural land use area
	2. Prevent agricultural land degradation
	3. Improving agricultural land fertility and stabilizing and improving productivity
	4. Appropriate management of agricultural, livestock and organic waste
	5. Eco-friendly recycling of livestock manure

The final goal of agricultural development pursued by the Mongolian government and the sub-goals related to it can be summarized into five points as follows.

① The area of agricultural land use must be steadily expanded. Among the agricultural land area of more than 100 million hectares, the crop cultivation area is only about 1.3 million hectares. In order to provide sufficient supply of agricultural and livestock products, it is necessary to secure additional crop cultivation area. In addition, there is a challenge to minimize non-fallow land within the crop rotation and fallow system. Expanding and securing the absolute agricultural area is an important policy goal.

② Preventing the increasing devastation of agricultural land. With the abandonment of agricultural use due to soil loss and erosion, 61.4% of the agricultural area is in a state of severe erosion. In addition, it is diagnosed that 47,000ha (0.4%) of the forest area is being degraded. There is a lot of room for the deterioration of farmland to accelerate due to climate change and land-expropriating methods. Therefore, it is necessary to establish and implement policies in response to the devastation of agricultural lands.

③ The declining fertility of farmland must be improved while simultaneously stabilizing and improving the productivity of agricultural products. The organic matter content of Mongolian agricultural soil is less than 2.5% in 70.7% (579.3 thousand ha). Only 15.1% is said to contain more than 3% organic matter. In addition, agricultural soil is diagnosed as lacking 60% of nitrogen, 77% of phosphorus, and

88% of potassium. There are also witnessing large fluctuations in agricultural production and production per unit area every year. Increasing fertility and stable production are important agricultural policy goals.

④ Appropriate management of agricultural, livestock and organic waste must be achieved. Large-scale livestock farming is generating large amounts of organic waste. With the acceleration of urban concentration of population, the amount of various wastes generated is also increasing, especially in Ulaanbaatar. However, the management of the generation and treatment of various organic wastes is not transparent. There are not even basic statistics on how much livestock waste is recycled to produce organic fertilizer. And in rural areas, livestock waste and household waste are being thrown away indiscriminately in government-designated places as well as non-designated places, but an appropriate management system is insufficient. Administrative power is also lacking, making proper management difficult. What is clear is that this problem must be corrected in the future.

⑤ Mongolia must aim for eco-friendly recycling of livestock waste. The amount of general organic waste generated annually exceeds 3 million tons, and the amount of livestock waste generated from livestock is estimated to be close to 30 million tons per year. However, if it estimates the recycling rate focusing on the metropolitan area, the recycling rate of organic waste is around 20%. If such agricultural, livestock and organic wastes are properly managed and recycled, economic and environmental problems can be improved and economic benefits can be achieved. It could become a natural policy issue.

If the goals of the proposed policy are smoothly achieved, the Mongolian government's goal of increasing domestic supply of agricultural and livestock products and processed foods will be achieved. If various organic resources can be recycled during this process, economic and environmental benefits can be achieved. In particular, if organic waste resources are composted, it is possible to develop not

only agriculture but also related forward and backward industries and create employment.

It is possible to preserve soil and improve soil strength by producing and supplying organic fertilizers using organic resources. In addition, it will be possible to achieve effects such as increasing agricultural productivity, increasing production of safe agricultural products, and resulting in improved self-sufficiency in agricultural products and increased farm household income.

The effect of environmental protection can also be achieved through the establishment of a resource circulation system between cultivation and livestock farming using organic matter as a medium and agricultural development through this. It is expected that a wide variety of benefits can be obtained when producing and supplying organic fertilizers through recycling of organic resources.

1.2. Organic Fertilizer Supply Strategy

In terms of the supply of organic fertilizers, three intermediate means can be selected to achieve the final and intermediate goals of agricultural development pursued by the Mongolian government.

① In addition to basic policies for agricultural development, agricultural equipment supply and support policies, specifically policies to promote production and consumption of organic fertilizers, must be prepared and implemented. A mid- to long-term development and development strategy that includes equipment and materials related to important agricultural production must be established. Although it is a low-level agricultural policy, what actually drives agricultural development is agricultural equipment and technology.

② Based on the established policy, that is, the organic waste management policy must be subdivided and specified within the comprehensive agricultural equip-

ment policy. In advance, basic information on the generation, treatment, and recycling of various types of organic waste resources must be accumulated. Based on this, a comprehensive policy on how to utilize organic waste resources must be established at the national level. This is because organic waste resources can be used to produce not only fertilizers but also feed and other products.

③ Once a comprehensive plan including the management and use of organic resources is prepared, a production strategy for organic fertilizers must be established and implemented.

It is necessary to systematize and specify policies while maintaining the consistency of agricultural policy → agricultural materials policy → organic resource utilization policy → organic fertilizer production policy. A strategy on how to produce and use organic fertilizers must be developed and implemented.

〈Table 4-2〉 Intermediate means of achieving organic fertilizer supply goal

Intermediate means	1. Strengthening agriculture and agricultural equipment support policies
	2. Implementation of organic waste management policy
	3. Expansion of organic fertilizer production

In order to implement strategies and policies related to the supply of organic fertilizers, organic fertilizers must be produced continuously. Looking at the major variables and situations related to the current production of organic fertilizers in Mongolia, it can be seen that there are many challenges that need to be solved.

First, as is well known, the amount of raw materials needed to produce organic waste resources, that is, organic fertilizers, is sufficient. As the size of livestock raised within a certain area is increasing and intensive slaughter is taking place, the generation of organic waste from livestock is large and intensive. Therefore, if the system necessary for proper management of waste is established and implemented, it will become easier to turn organic waste resources into raw materials for producing organic fertilizer.

Second, currently, in many cases, such organic waste is managed inappropriately. As witnessed in the field, waste is indiscriminately disposed of, and waste in designated areas is a mixture of organic and inorganic waste. In the case of livestock waste, it is not properly disposed of at the appropriate time, causing various environmental problems. These problems must be resolved through the cooperation of policies, systems, and relevant people (organizations).

Third, climatic conditions are not favorable for year-round production of organic fertilizers. The winter is long and the temperature is too low for efficient and effective fermentation to occur. Spreading the produced fertilizer is also difficult. As a result, most organic fertilizer production companies temporarily ferment in the open field, transport the fermented product, package it, and sell it. Large-scale storage and storage facilities are needed for mass production and distribution.

Fourth, the most important things in the production of organic fertilizers are production capacity and sales, but both are insufficient. The level of development of the manufacturing industry in Mongolia is low, making it difficult to independently procure various facilities and equipment necessary for fertilizer production. Mongolia is still receiving help from foreign countries in terms of production facilities and production methods. In some cases, equipment was imported from China. Because the market for produced organic fertilizers is small, the distribution system is not stable.

Fifth, farmers are having difficulty purchasing agricultural materials. The reason why farmers must purchase and use organic fertilizers is because there is no private benefit in purchasing and using organic fertilizers. The problem is a lack of effective demand. In other words, how to grow the organic fertilizer market is becoming a more important policy goal before producing organic fertilizers.

With reference to the problems presented above, the research team have organized four strategies to supply sufficient organic fertilizers in Mongolia. In fact, there may be more required than just the strategies presented here. However, here

the research summarizes only those strategies that are considered most important, targeting only organic fertilizers.

〈Table 4-3〉 Mongolia's organic fertilizer industry conditions and supply strategy

Organic fertilizer production conditions	Organic waste resources are abundant
	Various damages occur due to improper management
	Technical limitations on year-round production due to climatic conditions
	Lack of production-related technology and capital
	Lack of demand for final organic fertilizers
↓	↓
Supply strategy	1. Strengthening policy support
	2. Strengthening effective demand
	3. Distribution and consumer development
	4. Strengthening capital and technological cooperation

1.2.1. Strengthening Policy Support

The most important thing is the government's policy will. it must be established a commitment to proper management and efficient recycling of organic waste resources and establish systems, laws, and policies to make this happen. If necessary, policies that can solve related conditions or problems must be prepared and implemented.

1.2.2. Strengthening the effective demand for fertilizers in agricultural and livestock industries

The most important factor in expanding the supply of organic fertilizers is the increased use of manufactured organic fertilizers. The goal is to expand the market size. Soil testing and soil improvement consulting should also be provided as auxiliary support for this purpose. If the effective demand from agricultural and livestock producers is insufficient, the government must strengthen the current price

subsidy policy. In addition, tree planting projects and land power improvement projects implemented as national policies in Mongolia will contribute to expanding the size of the organic fertilizer market.

1.2.3. Development of distribution and consumers

After producing organic fertilizers, a stable distribution channel must be established to reach consumers. In the long term, division of labor between production, sales, and consumption is necessary. A stable supply base and supply entity for the sprayed users is needed. In addition, the use of organic fertilizers should not be limited to agricultural land but should be expanded to include pastures and forests. Planting one billion trees and supporting related facilities and equipment to strengthen spraying on pastures are also important strategies.

1.2.4. Strengthening capital and technological cooperation

In order to participate in organic fertilizer production, the necessary technology and economic feasibility of the business must be realized. There is a lot of room for improvement on the technical side. The problem is securing capital, and if the goal is to recycle organic resources at a national level and spray and use organic fertilizers on agricultural lands, pastures and forest areas, the government must provide support. This is because the public benefit is considered to be greater than the private benefit. In addition, it takes a considerable amount of time for the final demand to reach the break-even level of organic fertilizer companies, or in other words, for the organic fertilizer market to grow sufficiently. First, support for facilities, equipment, and related systems and policies at the national level is needed.

2. Korea-Mongolia Cooperation Plan (draft)

2.1. Premise of Establishing Cooperation Area

As summarized above, four factors are essential for expanding the production and supply of organic fertilizers using bio resources. Of course, there may be countless sub-projects and policies that make up the four elements, but here Mongolia will only consider those that are considered relatively important. In particular, the research team will review the areas that are deemed urgent, reflecting the circumstances of Korea and Mongolia.

In fact, the area setting can be subdivided and organized, but actual cooperation cannot be confirmed in advance because it is governed by the scale and period of the project. If the Mongolian government develops related policies in the future, it will be able to create and utilize detailed measures and policies by referring to the case of Korea.

Mongolia's demands, obtained through interviews with Mongolian officials and field surveys, based on four areas and in order of priority, were as follows. In other words, it is judged reasonable for the areas and details of cooperation between Korea and Mongolia to be determined according to the priorities below.

1. Strengthening capital and technological cooperation
2. Development of distribution and consumers
3. Strengthening effective demand for agricultural and livestock producers
4. Policy development and implementation

2.2. Cooperation Plans by Sector

The current situation between Korea and Mongolia and cooperation plans were organized according to the priorities of four areas. The expected role of the Korea

Rural Economic Institute in the implementation process of mutual cooperation was also summarized. Although it has been organized into four areas, if necessary, parts that affect each other can be reorganized and utilized in an integrated manner.

Because only the overall direction and important policy elements under the four areas were presented, more specific factors will ultimately be able to be reorganized through in-depth discussions with Korean and Mongolian officials and experts.

2.2.1. Strengthening Capital and Technological Cooperation

❍ Capital and technology situation by country

Content	Mongolia	Korea
production line	• Outdoor production and mostly simple facilities • Some indoor facilities use foreign materials • Installation of some semi-automatic packaging facilities, etc.	• Establishment of domestic large-scale factory production facilities • Most have fermentation facilities and automation facilities • Use of product packaging and shipping robot technology, etc.
production equipment	• In the open field, mainly used as a rod • In some cases, use of stirrers and forklifts, etc.	• In-house production and installation of automated stirrer • Owning various forklifts and transportation-related equipment, etc.
storage facility	• Lack of storage facilities • Difficulty in off-season production and stockpiling, etc.	• Most have large warehouse-type storage facilities • Production possible in the off-season, operation possible all year round, etc.
Material production company	• Low-tech domestic facilities and equipment production companies • Difficulty in independent production due to low domestic market	• Domestic production and supply of necessary facilities and equipment • Sufficient material development and supply capacity • Smooth connection with related new businesses and technology
production technique	• Focus on open field fermentation, seasonal production possible • Fermentation level using simple livestock manure • High quality, lack of versatility, etc.	• Most indoor fermentation, year-round production • Various facility types, use of raw materials • Securing world-class fermentation technology • Development of various products, etc.

❍ Cooperation goal: Transfer of Korean facilities, equipment, and fermentation technology

❍ Cooperation plan

Subject	Mongolia	Korea
Government	• Discussing cooperation in support of organic fertilizer-related projects with Korea and devising necessary measures	• Looking for cooperative response measures in response to Mongolian demand and support for related companies
Organic fertilizer production company	• Identification of organic resources and organic fertilizer demand in the region • Maintaining a list of necessary production facilities and equipment in response to demand • Confirm production-related facilities, equipment, and scale, and create a blueprint for future development • Establishment of a human resources training plan to acquire related technologies and promotion of cooperation with Korea, etc.	• Identification of facility and equipment scale through on-site investigation in Mongolia, consultation with local partner companies • Advice and support in creating future blueprints • Technology transfer and invitation training when necessary through local dispatch of technical personnel • Regular strengthening of exchanges and cooperation with Mongolian entrepreneurs, experts, and government officials, etc.
Facility and equipment production company	• Find ways to produce and supply necessary facilities and equipment • Find ways to secure the basic foundation, etc.	• Establishment of partnership with relevant Mongolian companies • Providing local necessary basic technologies and assets, etc.
KREI	• In cooperation with the Korea International Cooperation Agency (KOICA) Mongolia Office and the Rural Development Administration Overseas Agricultural Development Cooperation Project (KOPIA) Mongolia Center, organic material demand was identified by region in Mongolia. • Conduct basic research on companies and consumers necessary for production and technological cooperation • Support for linkage between the Korean and Mongolian governments and companies and support for creating blueprints for each country and company • Past-related cooperation projects between Korea and Mongolia, analysis of results, support for use in policy development, etc.	

2.2.2. Development of distribution and consumers

❍ Capital and technology situation by country

Content	Mongolia	Korea
Distribution/ price	• Insufficient specialized distribution system due to small market size • Price determination by individual companies • The market itself is in a pre-modern state • opacity in linking pricing and quality, etc.	• Dualization of National Agricultural Cooperative Federation channel and private sales route • Indirect price determination through consultation with Nonghyup • Price differentiation based on quality
Consumption support	• Individual consumers: Small quantity demand centered on horticultural crops	• Large-scale demand support for all farms, focusing on field crops

Content	Mongolia	Korea
	• Public institutions: Possible demand for pasture and forest development	• Demand for small public institutions
Quality improvement	• There is room for improvement in the distribution and quality control system.	• Preparation of a detailed management system and regulations, etc. • Enforcement of strong government management, etc.

❍ Cooperation goal: Establishment of distribution system and development of consumer destinations

❍ Cooperation plan

Subject	Mongolia	Korea
Government	• Secure and implement distribution and quality control systems • Initial product price government management • Strengthening research and promotion for consumer development	• Support for systems and policies related to Korea's distribution and consumer development, etc.
Companies related to the project	• Efforts to build a systematic distribution and sales organization • Thorough product price and quality control	• Providing know-how for distribution management of organic fertilizers • Support methods to respond to time gaps between production and consumption • Support for the introduction and utilization of the list disclosure system
KREI	• Providing Korean fertilizer distribution system, price and quality control system and application methods • Providing expert advice in establishing an efficient organic fertilizer distribution system in Mongolia	

2.2.3. Strengthening effective demand for agricultural and livestock producers

❍ Fertilizer demand status by country

Content	Mongolia	Korea
Consumer characteristics	• The number of consumers and scale of demand are small, and most of them are fruit and vegetable farms, especially facility farms. • Large-scale potential demand exists for soil restoration and forest protection at the national level.	• Most demand from field crop farmers • Recently, demand for waterworks has also increased. • Public institutions and urban agriculture demand, small-scale • The effective demand of consumers is at a significant level

Content	Mongolia	Korea
How to increase demand	• The frequency and target of soil surveys, which are basic information on fertilizer use, are minimal. • Farmers' awareness of the need for organic fertilizers is low. • Insufficient education and promotion for consumers • 30% subsidy for purchase price, but small budget • Less government projects in response to consumption expansion, etc.	• Increasing the ease of selecting necessary fertilizers by providing precise soil information on agricultural land • Implementation of fixed price support (central government + local government) for the purchase price of organic fertilizers • Various business support and large-scale budget support for livestock waste (raw materials) processing • In parallel with other organic material support projects, etc.

❍ Cooperation goal: Differentiating characteristics and response plans by consumer group

❍ Cooperation plan

Subject	Mongolia	Korea
Government	• Estimate and utilize the amount needed for public projects • Annual project volume and budget allocation, etc.	• Professional support when establishing a business plan • Discussion and discovery of organic fertilizer demand support projects
Demand promotion plan	• Promoting regularization and precision of soil surveys • Strengthen education and promotion for consumers • Expanding the scale of purchase price subsidies • Small government budget in response to increased consumption, etc.	• Providing Korean soil survey and utilization system • Provision of professional opinions when estimating required budget and considering various support methods • Inspection of agriculture-related projects, finding support methods, etc.
KREI	• Support from Korean experts when conducting organic fertilizer demand surveys and establishing supply plans • Support for review of applicability of various consumption promotion policies of Korea to Mongolia • Expansion of Mongolia's unique market, support for finding ways to stimulate consumption, etc.	

2.2.4. Policy development and implementation

❍ Policy status by country

Content	Mongolia	Korea
Organic Farming Ingredients Policy	• Main development strategies exist for each stage • Insufficient detailed unit business structure	• Implementing a five-year plan for high-level eco-friendly agriculture • Promoting separate organic agricultural materials and related livestock waste treatment projects by linking them.
Solidarity with related organizations	• Overall, the scale of the business is small. • Small government-related organizations related to organic materials	• Maintain organic relationships between government agencies related to organic materials

❍ Cooperation goal: Transfer and utilization of Korean facilities, equipment, and fermentation technology

❍ Cooperation plan

Subject	Mongolia	Korea
Government	• Specify policy establishment to suit reality • Policy is established to reflect the fact that policy support organizations are small and small.	• Policy target and demand are relatively large. • Support to find areas and ways to introduce Korea's various policies to Mongolia
Institutions related to the project	• Arrangement and implementation of support projects to respond to policy goals at each stage that can be implemented	• Share with Mongolia problems in the process of implementing government policies
KREI	• Provides a summary of the implementation and problems of Korea's eco-friendly agricultural policy • Provides information on fertilizer policy and related systems, etc. • Formation of a consultative body of agricultural and organic material experts in Korea and Mongolia, support for activities, etc.	

2.3. Step-by-step Cooperation Method (example)

❍ Step 1: Designate business site and set size

- Through analysis and review by Korean and Mongolian experts, a blueprint for an appropriate-sized organic fertilizer production plant was drawn up in the area expected to have the greatest ripple effect.

❍ Step 2: Construction of organic fertilizer plant facilities and equipment
  - Create and utilize a list of facility size, facility type, internal equipment, etc., considering the amount of bio raw materials to be processed, product production period, storage period, etc.
  - A list of necessary facilities (intermediate storage facilities) and equipment related to the distribution, transportation and spraying of produced organic fertilizers is also prepared and utilized with the help of experts.

❍ Step 3: Establishment of a production technology system suitable for Mongolia within the organic fertilizer factory
  - Establishment of testing and standardization processes for fermentation facilities and methods in response to the Mongolian climate
  - Research on appropriate fermentation mixing ratios for each type of raw materials and auxiliary materials, use of results, etc.

❍ Step 4: Establishment of a linking system of production, distribution, and consumption
  - Production adjustment through estimation of final consumers and consumption volume by period
  - Establishment of organization for large-scale spraying at regional level
  - Finding and implementing supply methods for small-scale consumers, etc.

❍ Step 5: Implementation and strengthening of demand stimulation policies
  - Strengthening soil analysis and strengthening education and promotional support simultaneously with the project
  - Various support policies and expansion of price subsidies to increase effective demand, etc.

3. Proposal for Official Development Assistance(ODA) Project

3.1. Facility specifications and budget

❍ Installation and operation of fermentation facilities utilizing organic resources in Bayanzurkh district (BZD), Gatsuurt waste collection point

- Establish a high-quality compost production model using organic waste resources
- Organic waste processing capacity: 700 tons per year

❍ Basic specifications and conditions

- Calculate the ratio (by volume) of auxiliary materials (bulking) and organic waste as 1:2. Other conditions are as follows.

〈Table 4-4〉 Starting data for sizing the installation

Parameter	Organic waste	Bulking	Mixture
Quantity - Mass (t·year-1)	700.0	161.5	861.5
Apparent density (t·m-3)	0.65	0.3	0.54
Quantity - Volume (m3·year-1)	1,076.9	538.5	1,599.2
Mixing ratio (vol: vol)	2	1	-
Total solids (% o.f.m)	25	75A	40.1A
Volatile solids (% o.d.m)	80	85A	81.8A
Real density (t·m-3)	1.6A	1.6A	1.8A
Porosity (%)	43A	78.4A	56.9A
C/N total rate			17.4A

Note: A data shown and calculations made according to the formulas of the "Guide for Support for Design and Exploitation of Compost Plants of the Catalan Waste Agency".

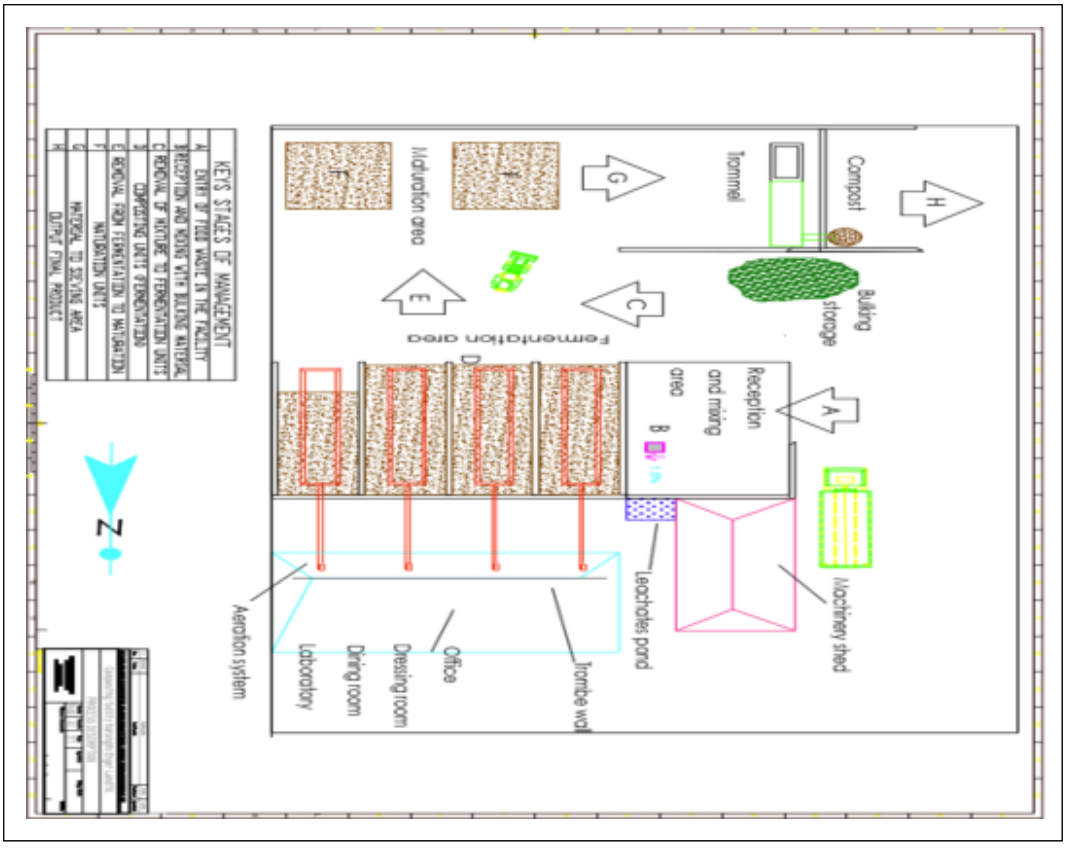
❍ It is estimated that 2.7 tons of organic waste will be transported per day, 5 business days per head, 52 weeks per year.

〈Table 4-5〉 Work regime of the installation

Parameter	Value	Units
Operating weeks	52	weeks year-1
Operating days	5	days week-1
Inputs to the facility		
Organic waste	700.0	t year-1
	13.5	t week-1
	2.7	t day-1
	20.7	m3·week-1
	4.1	m3·day-1

❍ Proposed system design

- The composting system proposed in the pilot project is a fixed system with forced ventilation.



❍ Overview of ODA Project Proposal

Note	Details		
Project title	Farmland soil improvement project through livestock manure resource (organic fertilizer) in Bayanzurkh District, Mongolia		
Project period and budget	▣ Period: 4 years ▣ Total budget: 2.81 million USD		
Target countries and regions	Bayanzurkh district, Ulaanbaatar provincial municipality, Mongolia		
Beneficiaries	Agricultural and livestock farms in Bayanzurkh District, Ulaanbaatar, Mongolia		
Recipient country partner organization	Ministry of Food, Agriculture and Light Industry, MOFALI)		
Project Purpose	Improving farmland soil and increasing agricultural productivity through recycling and utilization of organic waste in Mongolia		
Project contents	Outcome		Establishing an organic waste resource system and laying the foundation for revitalizing the organic fertilizer industry
	Outputs		• Supported local customized livestock manure recycling facilities and related equipment • Improved organic fertilizer support policy and established detailed support strategy • Public officials with enhanced organic fertilizer marketing and farmer guidance capabilities • Farmers with improved agricultural productivity by using organic fertilizers
	Activities	Facility construction	• Estimated budget: 1.82 million USD • Organic waste recycling (composting) facilities (fermentation, composting, packaging facilities, etc.), waste treatment plants, village and public project unit fertilizer storage sites, management offices, etc.
		Equipment support	• Estimated budget: 0.73 million USD • Material transportation vehicles (trucks, forklifts, tractors, auxiliary machines, etc.), equipment inside resource processing facilities (agitators, loaders, excavators, temperature measuring instruments, etc.). office equipment
		Dispatch of experts	• Estimated budget: 0.21 million USD • Dispatch of experts in organic fertilizer production technology, construction, farming, marketing, agricultural guidance, and policy advice
		Capacity building	• Estimated budget: 0.05 million USD • Invitational training for practitioners and managers, workshops for local farmers, and local agricultural guidance

3.2. Local situation

❍ Current status of processing and management of related resources

- When disposing of waste in Ulaanbaatar, there is no distinction between organic and inorganic waste.
- There are many organic resources in the surrounding livestock waste disposal site.
- Insufficient supply and demand information on auxiliary materials when producing organic fertilizers
- Difficulties with fermentation, production, and consumption remain due to low winter temperatures
- Insufficient organic fertilizer management standards

3.3. Critical Facilities and Equipment (Considerations)

The comprehensive flow of organic fertilizer production and use and the factors that must be considered at each stage are diverse.

At the current stage, when planning a cooperation project with Mongolia, it appears that the focus will be on the production sector. However, because production can be continuous due to consumption, here the research have summarized the factors that must be considered when planning and establishing strategies in each step.

If Mongolia want to promote the production and consumption of organic fertilizers using organic waste resources, the need for a general organization that can plan and implement policies as a whole is considered important when looking at the local situation in Mongolia.

❍ Organic fertilizer production-use flow and components

① Production

Component	Details
Main materials	Livestock manure, food waste, processed food residues, slaughter by-products
Sub-materials	Sawdust, bushes, twigs, thinned trees
Material transportation	Trucks, Tractors and Auxiliary Equipment
Fermentation method	Facilities and equipment are determined differently depending on the fermentation method.
Production facilities	Building specifications and building type, production internal material introduction and fermentation facilities, composting and packaging facilities, etc.
Management facilities	Office, various equipment storage and repair facilities
various equipment	Agitators, forklifts, loaders, excavators, temperature measuring instruments, and other equipment
Related personnel	Production technician, manager

② Distribution

Component	Details
Distribution organization	Establishment of fertilizer agency
Product transportation	Trucks, forklifts, and other equipment
Storage facility	Storage
Management equipment	Office, various equipment, storage, and repair facilities

③ Utilization

Component	Details
Individual demand	Support for small-scale effective demand of individual farmers
Public demand	Determination of large-scale consumer base for national business
Storage yard	Village level, public project level fertilizer dump warehouse
Carriage	Tractors, trucks, forklifts, and other equipment
Spreading equipment	Small spray trucks, large spray trucks, tractor-attached sprayers, etc.

When planning the project, a preliminary demand survey is conducted on the necessary equipment and facilities at each stage from production of organic fertilizer to final use. Then, the project must be promoted while taking necessary measures (systems and decisions) related to securing the necessary equipment and materials on site. Since the above is just an example, it is desirable to adjust it through future consultations with Mongolia.

Reference

Changyong-Kang, “Korean’s Main Policies for Ordinary and Byproduct Fertilizer”, 「Start-up Workshop on the 2023 Kapex Joint Research in Mongolia」, 2023. 9. 25

Changyong-Kang. 2018. 「Korean fertilizer, pesticide, and agricultural machinery policies and future」, Korea Rural Economic Institute.

German Federal Ministry of Food and Agriculture (BMEL) and GFA Consulting Group GmbH. 2016. “Market Study Part 1: Demand and Usage of Agrochemicals in Mongolia (Fertilizers and Pesticides)”. 「German – Mongolian Cooperation Project Sustainable Agriculture」.

German Federal Ministry of Food and Agriculture (BMEL) and GFA Consulting Group GmbH. 2016. “Market Study Part 2: Supply of Agro-Chemicals in Mongolia (Fertilizer and Pesticides)”. 「German – Mongolian Cooperation Project Sustainable Agriculture」.

German Federal Ministry of Food and Agriculture (BMEL) and GFA Consulting Group GmbH. 2020. “Risk management in Mongolian vegetable production -opportunities and challenges”. 「German – Mongolian Cooperation Project Sustainable Agriculture」.

Park Ki-hwan, 2012, “Strategic development plan for agriculture and forestry downstream industries: Trends and development plans for the inorganic fertilizer industry - Focusing on ways to improve the supply system” Korea Rural Economic Institute.

Seo Dae-seok, Seo Dong-ju, and Kim Boo-young. 2022. “Price trends and implications of major agricultural materials”, KREI Current Issue Analysis, No. 91 (September 19, 2022), Korea Rural Economic Institute.

Undrakh-Od Baatar. 2023. “Current Status of the Fertilizer Industry and Policies in Mongolia”.「Start-up Workshop on the 2023 Kapex Joint Research in Mongolia」.

Undrakh-Od Baatar. 2023. “Detailed implementation plan for large-scale pilot project”. Central Asian soil science society.

〈Online references〉

Agricultural and Forestry Business Information System, AgriX. 〈https://uni.agrix.go.kr/webportal/main/portalIndex.do〉.

FAOSTAT 〈https://www.fao.org/home/en〉. date: 2024.1.20.

German – Mongolian cooperation project Sustainable agriculture 〈https://www.dmknl.de/de/projekthintergrund.html〉. date: 2024.1.20.

Korea Fertilizer Association website. 〈https://fert-kfia.or.kr/new/02_info/list.asp?code=bbs02_3〉. Date: 2024.2.21.
Korea Law Information Center website. 〈https://www.law.go.kr/〉. Date: 2024.2.11.
Livestock Environmental Management Institute website. 〈https://lemi.or.kr/〉.
Mongolia Cabinet website. 〈https://cabinet.gov.mn/〉. Date: 2024.2.21.
Mongolia Judiciary website. 〈http://https://www.legalinfo.mn〉. date: 2024.2.21.
National Agricultural Products Quality Management Service, eco-friendly certification statistics. 〈http://www.enviagro.go.kr〉.
SIS website. 〈https://soil.rda.go.kr/soil/index.jsp〉. Date: 2024.2.11.