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Keywords:

Greenhouse farming; Local vegetable market; Vegetable import; Mongolia.

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Disclaimer

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The contents of this report are those of the authors and do not necessarily reflect the views of USAID or the United States Government. Additionally, Development Solutions NGO served as the client representative for this study and does not bear any responsibility for the study's findings or conclusions.

LIST OF ABBREVIATIONS

AD	Agricultural Department
ERI	Economic Research Institute
FAO	Food and Agriculture Organization
GDP	Gross domestic product
GIZ	German Development Agency
HSES	Household Socio-Economic Survey
MCGA	Mongolian Customs General Administration
MOFALI	Ministry of Food, Agriculture and Light Industry
NSO	National Statistics Office

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1.INTRODUCTION

Previous studies have partially addressed greenhouses in reports by international organizations supporting Mongolia's agricultural sector (SECiM, 2018; Development Solutions, 2023; ERI, 2019). While the German Development Agency (GIZ) recently released informative resources for farmers, including the "Winter Sunny Greenhouse Business Plan Development Guide" (GIZ, 2023a) and "Greenhouse Technology Guide" (GIZ, 2023b), detailed research on Mongolian greenhouse farming and the greenhouse vegetable market remains scarce.

Purpose of the study

This study aims to comprehensively understand the dynamics of Mongolia's greenhouse vegetable market. It will identify key factors for ensuring sustainable growth within the greenhouse industry and analyze domestic greenhouse capacity and supply levels.

In this context, the research was conducted with the following objectives:

- Estimate supply from domestic greenhouses.
- Calculate the proportion of imported greenhouse vegetables in the overall supply.
- Assess the demand for greenhouse vegetables.
- Analyze issues related to supply-demand imbalances and market price fluctuations.
- Identify current challenges faced by greenhouse businesses.
- Conduct economic viability assessments, profitability analysis, and financial projections for greenhouse farming.

Survey Methodology

The study employed the following methodology:

- Analysis of administrative quantitative data: The study team collected detailed information on the total number, classification, capacity, and production of domestic four-season and summer greenhouses from the Ministry of Food, Agriculture and Light Industry (MOFALI) and the Agricultural Department (AD) of the capital city and provinces. It aimed to determine the supply picture of domestic production of greenhouse vegetables for each type of greenhouse vegetable.
- Secondary data analysis: An extensive examination of secondary data was conducted, comprising a review of recent studies, reports, and data

pertaining to greenhouse farming and statistics on greenhouse vegetables. This review utilized databases from the National Statistics Office (NSO), international organizations, and vegetable supply sources.

- In-depth interviews: In-depth interviews were conducted with 15 enterprises and farmers engaged in greenhouse vegetable cultivation. These interviews aimed to gather additional qualitative information on domestic greenhouse vegetable cultivation and to validate the accuracy of administrative data.
- Customs statistics analysis: Customs statistics were utilized to conduct a study, leveraging data from the Mongolian Customs General Adminstration (MCGA), aimed at assessing the influx of imported goods competing with domestically grown greenhouse vegetables. This study integrates the domestic production of greenhouse vegetables with imported supply to define the overall domestic greenhouse vegetable supply.
- Demand analysis: A thorough examination of the demand and consumption patterns of greenhouse vegetables was conducted using primary quantitative data from the Household Socio-Economic Sample Survey (HSES) of the NSO.
- Further demand analysis: To better assess the demand for domestic greenhouse vegetables, additional information was gathered through interviews with 15 major markets, supermarkets, and food chain restaurants that retail greenhouse vegetables.
- Analysis of market equilibrium was conducted utilizing supply and demand data for greenhouse vegetables. This study posits that the market's supply of and demand for vegetables cultivated in greenhouses can be determined by the following equation:

$$Supply_i = Domestic\ supply_i + Import_i = Demand_i$$

where, i, represents the variety and class of vegetables grown in the greenhouses. In this study, vegetables grown in greenhouses were classified into the following four categories. These include tomatoes, cucumbers, peppers, and leafy vegetables (such as lettuce).

The supply of various types of vegetables cultivated in greenhouses comprises both domestically grown produce and imports. This supply aims to satisfy domestic demand or its equivalent.

Also, in this study, we estimate the supply of each greenhouse-grown species by analyzing detailed information on domestic cultivation and imports. Additionally, it assesses the ratio of domestic cultivation to imports for each species. Furthermore, it examines the yield or productivity of greenhouse enterprises engaged in domestic cultivation.

The demand for greenhouse vegetables arises from population food consumption statistics. This consumption comprises the following two distinct types.

1. Consumption of greenhouse vegetables purchased by households or obtained freely from their own farms is elucidated through detailed quantitative data derived from the HSES, which provides a representative sample of the national and provincial populations. This data enables comparisons of greenhouse vegetable consumption across months, seasons, provinces, and various household demographics.
2. The consumption of greenhouse vegetables by household members for dining out is challenging to quantify in detail due to insufficient quantitative data. Therefore, we gathered information from representatives in the catering industry to estimate the volume of greenhouse vegetables utilized in food products, including final preparations sold at cafeterias, restaurants, and chain stores.

2. DOMESTIC GREENHOUSE INDUSTRY AND SUPPLY OF VEGETABLES

2.1. Greenhouse Farming

As of the end of 2023, registration data from the Agricultural Department of the capital city and 16 provinces indicate that 4,539 individuals and 415 enterprises are involved in greenhouse farming across these areas. Individuals operate greenhouses covering a total area of 717,308 square meters, while enterprises manage greenhouses totaling 890,906 square meters. The capital, Tuv, and Selenge provinces boast the largest areas of greenhouse cultivation by citizens, whereas 88.9% of the total greenhouse area operated by enterprises is concentrated in the capital city.

Table 1. The number of individuals and enterprises involved in greenhouse farming and the total greenhouse area

Provinces	Number of Individuals	Total area, m^2	Number of Enterprises	Total area, m^2
Arkhangai	127	15,217	0	0
Bayankhongor	18	4,523	2	14,380
Bayan-Ulgii	166	5,963	64	1,360
Bulgan	216	13,390	1	318
Govi-Altai	2	4,500	0	0
Govisumber	17	4,588	6	3,344
Darkhan-Uul	84	12,038	9	21,280
Dornogovi	338	74,263	-	-
Dornod	828	28,832	-	-
Dundgovi	123	13,919	18	4,524
Zavkhan	60	5,132	5	1,760
Uvurkhangai	229	12,813	54	17,388
Sukhbataar	359	74,566	-	-
Selenge	691	104,232	32	9,598
Tuv	291	111,445	109	18,019
Khuvsgul	256	17,057	7	3,582
Khentii	290	14,520	20	3,224
Ulaanbaatar	444	200,310	88	792,129
Total	**4,539**	**717,308**	**415**	**890,906**

Source: Statistical information prepared by provincial and capital agricultural departments

It should be noted that these statistics do not include data from provinces that actively grow vegetables, such as Orkhon, Khovd, and data from some provinces, such as Dornogovi, Dornod, were incomplete.

Table 2 presents the greenhouse area under cultivation categorized by type. It is evident that the majority, constituting 70.6%, are synthetic film or summer greenhouses. However, solar and glass greenhouses, suitable for winter use, represent 14.1% and 15.3% of the total area, respectively.

Table 2. Greenhouse area by type of greenhouse, m^2, 2023

№	Province	Solar	Glass	Synthetic film
1	Arkhangai	5,061	0	10,156
2	Bayankhongor	480	8,320	10,103
3	Bayan-Ulgii	1,000	200	6,799
4	Bulgan	1,260	0	0
5	Govi-Altai	0	0	4,500
6	Govisumber	1,430	0	5,094
7	Darkhan-Uul	14,960	1,464	13,594
8	Dundgovi	2,080	200	13,919
9	Dornogovi	870	0	0
10	Dornod	0	500	18,354
11	Zavhan	0	600	6,157
12	Uvurkhangai	3,065	490	26,945
13	Sukhbaatar	0	0	74,566
14	Selenge	6,820	784	106,226
15	Tuv	59,078	23,654	149,732
16	Khovd	1,890	0	6,758
17	Khuvsgul	150	4,640	15,849
18	Khentii	2,207	0	15,130
19	Ulaanbaatar	47,763	119,772	256,098
	TOTAL	**148,114**	**160,624**	**739,980**

Source: Statistical information prepared by provincial agricultural departments

Compared to provinces, the distribution of greenhouse types varies significantly. For instance, in Bulgan and Dornogovi provinces, all greenhouses are solar greenhouses, whereas in Gobi-Altai and Sukhbaatar provinces, synthetic film greenhouses dominate. Moreover, Arkhangai, Govisumber, Khovd, and Khentii provinces do not utilize glass greenhouses at all. In Ulaanbaatar, which boasts the largest greenhouse area, synthetic film covers 60.4% of the total area, glass covers 28.3%, and solar greenhouses cover 11.3%. Conversely, in Tuv province,

64.4% of the total greenhouse area is composed of synthetic film, 25.4% of glass, and 10.2% of solar greenhouses. In Selenge province, 93.3% of the total greenhouse area is composed of synthetic film, 6.0% of glass, and 1.6% of solar greenhouses.

Although additional information to verify the greenhouse area data is unavailable, insights can be gleaned from the statistics on the cultivation of vegetables in greenhouses. Table 3 displays the cultivated areas of cucumbers, tomatoes, and peppers across provinces and capitals as of 2023, sourced from the NSO's database. Notably, data on the cultivated area of leafy vegetables was not included in these statistics.

Nationwide, cucumbers, tomatoes, and peppers are cultivated from a combined area of 998.2 hectares, constituting 6.3% of the total vegetable cultivation area. Specifically, cucumbers take up 736.8 hectares, tomatoes cover 217.5 hectares, and peppers 44.1 hectares.

Table 3. Amount of area cultivated with vegetables, hectares, 2023

Province	Cucumber	Tomato	Pepper	A sum of three types	Vegetables - All	Percentage of vegetable area
Arkhangai	3.1	1.5	0.2	4.8	125.4	3.8%
Bayankhongor	6.7	5.7	1.4	13.8	127.6	10.8%
Bayan-Ulgii	14.0	8.5	0.0	22.5	157.5	14.3%
Bulgan	9.5	6.6	3.1	19.2	290.6	6.6%
Govi-Altai	7.4	3.0	1.0	11.3	71.6	15.8%
Govisumber	1.5	1.4	0.4	3.3	33.7	9.9%
Darkhan-Uul	117.1	2.8	0.7	120.7	1,641.4	7.4%
Dundgovi	2.7	1.9	0.9	5.5	23.1	23.6%
Dornogovi	24.9	4.9	1.1	30.9	95.2	32.4%
Dornod	18.6	15.7	3.3	37.5	190.0	19.8%
Zavkhan	3.4	1.4	0.3	5.1	182.8	2.8%
Uvurkhangai	8.5	10.8	2.0	21.3	303.3	7.0%
Umnugovi	9.7	15.6	2.5	27.7	94.7	29.3%
Orkhon	3.5	1.6	0.3	5.4	455.3	1.2%
Sukhbaatar	4.3	2.9	1.6	8.7	68.2	12.8%
Selenge	280.1	32.7	15.4	328.2	4,910.9	6.7%
Tuv	13.1	7.1	1.6	21.8	3,349.7	0.6%
Uvs	13.7	11.2	0.0	24.9	497.7	5.0%
Khovd	124.9	52.9	1.1	178.9	2,135.9	8.4%
Khuvsgul	22.6	11.1	2.9	36.6	340.2	10.8%

Khentii	10.0	5.6	1.3	16.8	295.3	5.7%
Ulaanbaatar	37.5	12.7	3.1	53.3	399.7	13.3%
Total	**736.8**	**217.5**	**44.1**	**998.2**	**15,789.7**	**6.3%**

Source: NSO database (www.1212.mn)

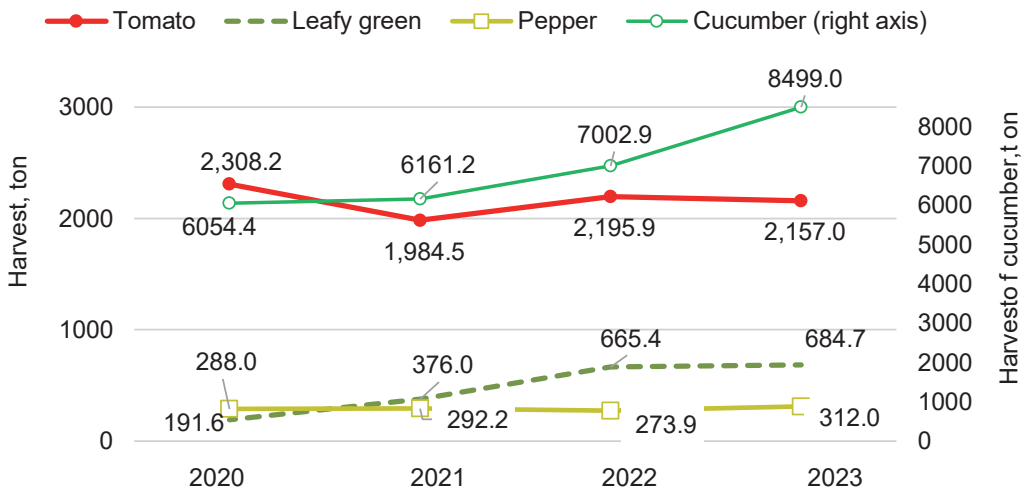
When comparing provinces, 280.1 hectares, or 38.0% of the total 736.8 hectares of cucumber cultivated in the country, were grown in Selenge Province. Khovd Province accounted for 124.9 hectares, or 17.0%, while Darkhan-Uul Province contributed 117.1 hectares, equivalent to 15.9% of the total cultivation area. In terms of tomatoes, 24.3% of the total area was planted in Khovd, 15.0% in Selenge, 7.2% in Dornod, and 7.1% in Umnugovi. Pepper cultivation showed that 35.0% of the total cultivated area was in Selenge, 7.4% in Dornod, 7.0% in Ulaanbaatar, and 6.9% in Bulgan provinces.

There appears to be a discrepancy between the data provided by the provincial and capital Agricultural Department (AD) and the National Statistical Office (NSO) regarding greenhouse use in Mongolia. According to Table 1, the provincial ADs report a total greenhouse area of 1,608,214 square meters across 17 provinces and the capital city. However, Table 3 from the NSO indicates a significantly larger total area of 7,613,000 square meters dedicated to cultivating tomatoes, cucumbers, and peppers in these same regions. This translates to a staggering 761.3 hectares. A closer look at this difference reveals that the NSO data likely encompasses both open fields and greenhouses for cultivating the mentioned vegetables. This hypothesis is supported by the fact that the NSO figure is roughly five times larger than the provincial ADs reported greenhouse area.

2.2. Domestic greenhouse vegetable supply

In this study, tomatoes, cucumbers, peppers, and leafy vegetables (such as lettuce) were considered greenhouse vegetables. Figure 1 shows domestic greenhouse vegetable harvest data for 2020-2023. From this point of view, the majority of the greenhouse vegetable harvest, about 60%, is made up of cucumbers, and the amount of the harvest tends to increase dramatically in recent years. In 2020, 6,054.4 tons of cucumbers were harvested nationwide, and in 2023, this amount increased to 8,499.0 tons. In general, the cultivation of cucumbers has increased significantly compared to the previous 10 years. For example, from 2010 to 2014, an average of 4,090 tons of cucumbers were harvested annually, while from 2015 to 2019, 3,993 tons were harvested.

Figure 1. Total harvest of vegetables, tons



Source: NSO database (www.1212.mn)

Tomatoes, the second most cultivated vegetable in greenhouses, experienced a peak without subsequent growth in recent years. National harvest figures for tomatoes declined from 2,308.2 tons in 2020 to 2,157.0 tons in 2023. Overall, tomato cultivation has remained relatively stable over the past decade. Between 2010 and 2014, an average annual harvest of 2,181 tons was recorded, contrasting with 1,991 tons harvested annually between 2015 and 2019.

The harvest of leafy vegetables such as cauliflower, broccoli, lettuce, spinach, and cruciferous vegetables remains significantly lower compared to cucumbers and tomatoes. However, their cultivation has seen a notable increase in recent years. For instance, in 2020, the annual yield of leafy vegetables was 191.6 tons, which surged to 684.7 tons by 2023. In contrast, pepper cultivation has remained stable at approximately 300 tons per year during this period.

Table 4 presents a comparison of vegetable harvest data across provinces as of 2023. Selenge province emerges as the leading producer of greenhouse vegetables and overall vegetable production nationwide.

Table 4. Vegetable harvest, tons, 2023

Province	Cucumbers	Tomatoes	Peppers	Leafy vegetables	Total greenhouse vegetables	Vegetables - All
Arkhangai	5.2	3.7	1.1	0.2	10.1	882.9
Bayankhongor	38.3	43.6	3.4	1.3	86.6	916.0
Bayan-Ulgii	118.0	64.2	0.0	1.5	183.7	1,555.6
Bulgan	47.3	21.8	4.5	19.5	93.1	2,426.3

Govi-Altai	42.1	16.0	3.4	0.6	62.1	412.1
Govisumber	19.5	17.3	5.5	0.5	42.7	275.1
Darkhan-Uul	1,763.8	30.4	11.5	50.2	1,855.9	25,636.3
Dornogovi	128.2	34.2	4.5	8.4	175.3	526.1
Dornod	133.1	109.2	16.6	17.9	276.8	1,687.4
Dundgovi	37.2	11.2	5.3	16.7	70.4	208.4
Zavkhan	29.7	6.7	2.2	6.9	45.5	1,326.0
Orkhon	252.8	23.1	7.6	32.1	315.6	9,866.3
Uvurkhangai	79.3	78.8	14.1	8.9	181.1	2,817.0
Umnugovi	77.9	219.9	7.1	0.6	305.5	670.5
Sukhbaatar	186.0	172.7	21.1	2.9	382.6	1,060.7
Selenge	3,481.7	329.1	145.5	155.0	4,111.2	86,271.3
Tuv	259.9	154.5	11.5	30.7	456.6	37,451.9
Uvs	108.9	69.7	0.2	0.2	178.9	4,351.4
Khovd	822.9	383.4	3.8	0.0	1,210.1	17,994.1
Khuvsgul	84.2	44.1	5.3	6.9	140.5	3,751.9
Khentii	92.5	49.0	5.9	2.0	149.4	3,476.3
Ulaanbaatar	690.8	274.5	32.0	321.8	1,319.1	4,817.2
Total	**8,499.0**	**2,157.0**	**312.0**	**684.7**	**11,652.6**	**208,380.6**

Source: NSO database (www.1212.mn)

Specifically, Selenge province cultivated 3.5 thousand tons, accounting for 41.0% of the cucumber harvest, followed by Darkhan-Uul with 20.8% and Khovd province with 9.7%. Khovd province also produced 383 tons, comprising 17.8% of the tomato crop, while Selenge and Ulaanbaatar contributed 15.3% and 12.7%, respectively. For peppers, Selenge province was the top producer with 146 tons, representing 46.6% of the total harvest, followed by Ulaanbaatar with 10.3%, and Uvurkhangai and Dornod provinces contributing 5.3% and 4.5%, respectively. Ulaanbaatar produced 322 tons of leafy vegetables, constituting 47.0% of the total harvest, with Selenge and Darkhan-Uul provinces contributing 22.6% and 7.3%, respectively.

In other words, the ADs from 14 provinces reported greenhouse vegetable harvests that equate to just 33.1% of the total vegetable harvest reported by the NSO for those same provinces. This discrepancy likely reflects the earlier observation – a significant portion of some greenhouse vegetables, like cucumbers, might be grown in open fields, mirroring the area data disparity.

Table 5. Greenhouse producers' harvest of greenhouse vegetables /tons/

№	Province	Harvest, ton
1	Bayankhongor	54
2	Govi-Altai	4
3	Govisumber	31
4	Darkhan-Uul	172
5	Dundgovi	101
6	Dornogovi	434
7	Dornod	74
8	Zavkhan	165
9	Uvurkhangai	227
10	Sukhbaatar	359
11	Selenge	447
12	Khovd	59
13	Khuvsgul	96
14	Khentii	686
	Total	**2,909**

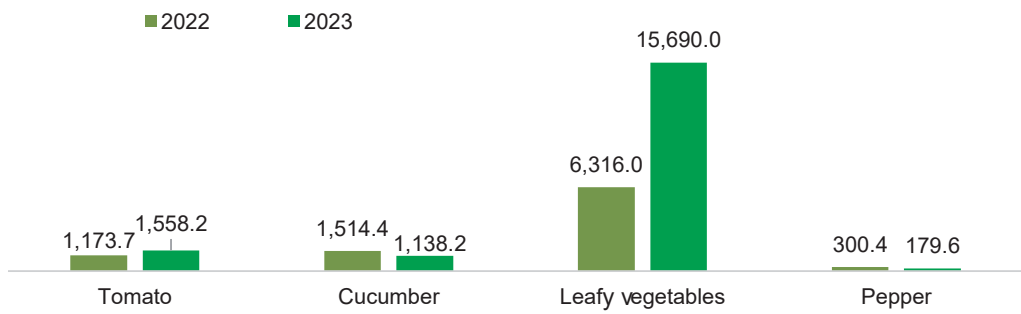
Source: Statistical information prepared by provincial agricultural departments

3. COMPETITION FROM IMPORTS

3.1. Import of vegetables

The import of four selected types of vegetables surged by 100%, rising from 9,304.6 tons in 2022 to 18,566.0 tons in 2023. This increase, illustrated in Figure 2, was primarily driven by a substantial rise in the import of leafy vegetables, which increased from 6,316 tons to 15,690 tons. The import of tomatoes has risen significantly from 1,173.7 tons to 1,558.2 tons. In contrast, there has been a decrease in the import of cucumbers (from 1,514.4 tons to 1,138.2 tons) and peppers (from 300.4 tons to 179.6 tons).

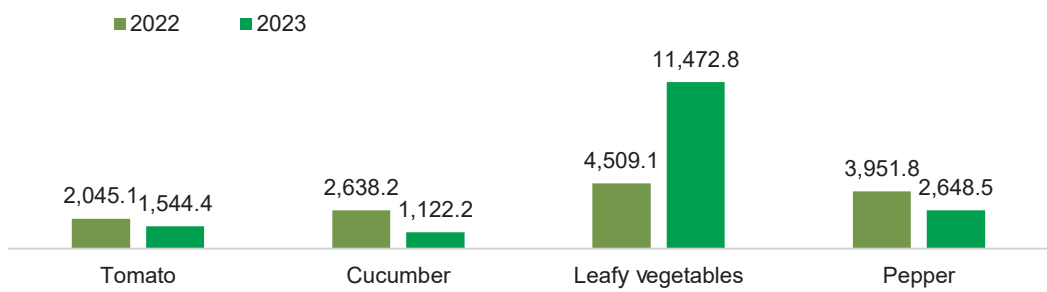
Figure 2. Import of vegetables, tons



Source: Mongolian Customs General Administration

Figure 3 compares vegetable imports in terms of MNTs. The four selected types of vegetables were imported for MNT 13.1 billion (~USD 4.2 million) in 2022 and MNT 16.8 billion (~USD 4.8 million) in 2023. Total imports increased by 28% in terms of MNT(16% in US dollars).

Figure 3. Import of vegetables, MNT million[1]

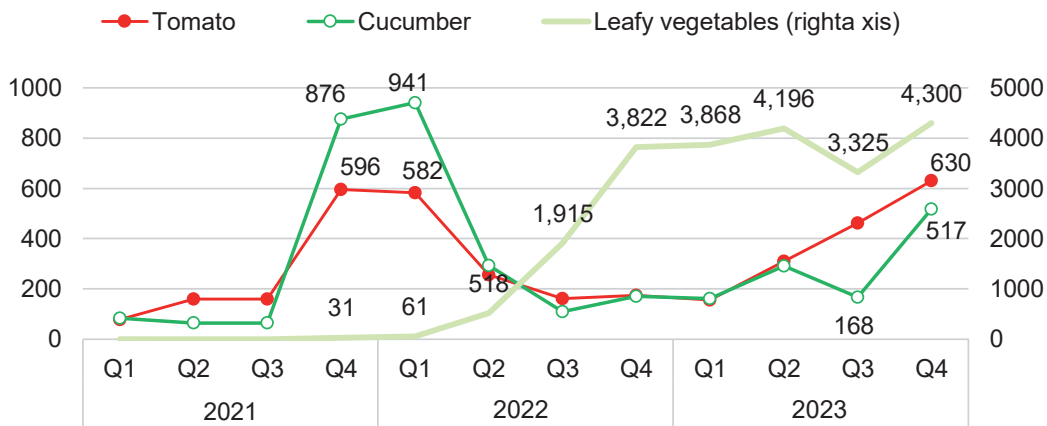


Source: Mongolian Customs General Administration

1 According to the announcement of the Bank of Mongolia, the average US dollar exchange rate for 2022 is MNT 3,144.83, and the exchange rate for 2023 is MNT 3,465.78.

The import volume of vegetables shows a seasonal pattern, typically rising during the first and fourth quarters of each year, with a notable decline in the third quarter. This cyclicality aligns with the domestic supply cycle of these vegetables.

Figure 4. Imports of vegetables, tons, by quarter

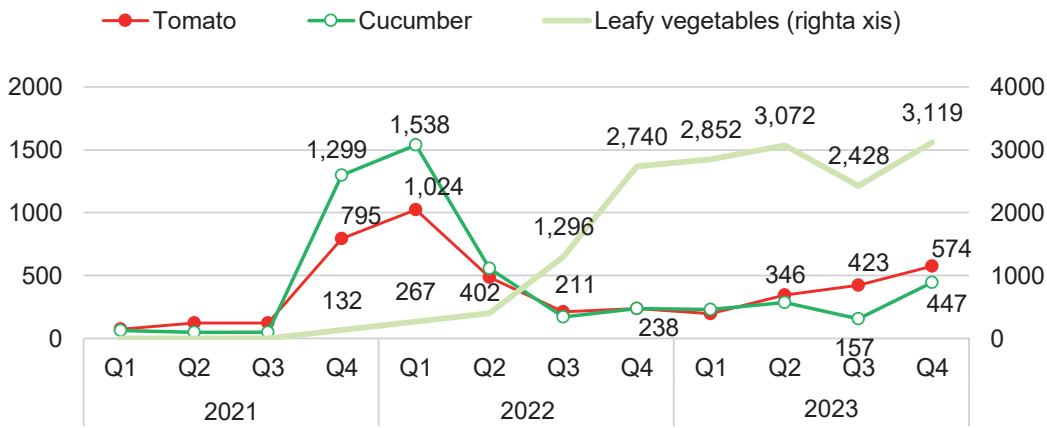


Source: Mongolian Customs General Administration

In late 2021 and early 2022, the import of tomatoes and cucumbers increased dramatically due to the relaxation of border restrictions from the COVID-19 pandemic and the recovery of imports. Also, because of the restrictions, the New Year and Lunar New Year holidays, which had not been celebrated for two years, were expected to be widely celebrated. As a result, the imports during the winter season did not increase much. In addition, especially in 2022, due to post-pandemic transport and logistics delays and the increase in food prices worldwide due to the Russia-Ukraine war, imports decreased. In the last quarter of 2023, the import of tomatoes and cucumbers increased dramatically from the previous quarters, following seasonal fluctuations. As for leafy vegetables, it is interesting that imports have increased sharply in all quarters after Q3 2022.

Figure 5 illustrates the monetary value of vegetable imports. The overall seasonality in vegetable imports mirrors the above. Expenditure on cucumber and tomato imports averaged between MNT 2-2.5 billion per quarter at the end of 2021 and the beginning of 2022, sharply declining thereafter. However, beginning in the fourth quarter of 2022, quarterly spending on leafy vegetable imports is expected to rise to approximately MNT 3 billion.

Figure 5. Import of vegetables, MNT million, by quarter



Source: Mongolian Customs General Administration

3.2. The ratio of domestic cultivation to imports

As of 2021, Mongolia's total domestic vegetable consumption amounted to 197.8 thousand tons. Of this total, 131.5 thousand tons, or 66.5%, were sourced from domestic production, while 66.3 thousand tons, equivalent to 33.5%, were imported (Development Solutions, 2023). To ascertain the ratio of vegetables cultivated domestically in greenhouses versus those imported and to assess the market's dependency on imports, we analyzed the domestic greenhouse harvest data detailed in Chapter 2 of this report alongside the import data provided in the preceding section.

Table 6 compares domestic cultivation and vegetable imports. The total supply of four selected types of vegetables, determined by combining imported and domestically harvested quantities, reveals that leafy vegetables constitute more than half of the total supply, followed by cucumbers and tomatoes, with peppers being the least supplied.

Table 6. Vegetable supply, import, and domestic cultivation, tons, 2023

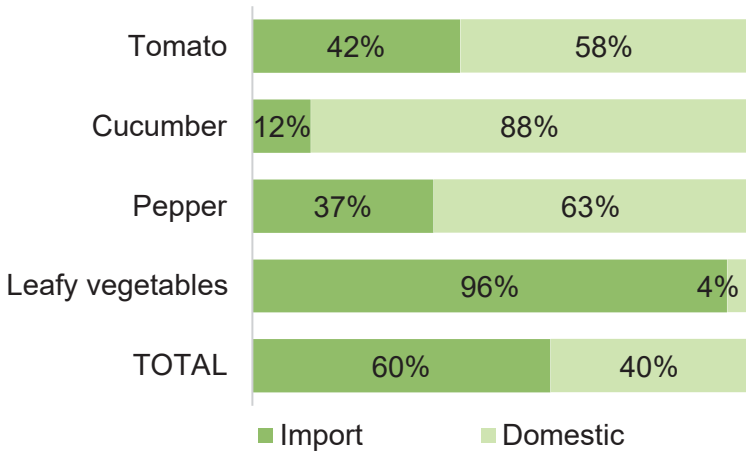
	Import	Domestic cultivation	Total
Tomato	1,558	2,157	3,715
Cucumber	1,138	8,499	9,637
Pepper	180	312	492
Leafy vegetables	15,690	685	16,375
Total	**18,566**	**11,653**	**30,219**

Source: Researchers' estimates based on NSO data

The ratios in Figure 6 illustrate the percentage of the total supply attributed to

each vegetable. Imports of these four types of vegetables constitute 60% of the total supply, with domestic cultivation contributing the remaining 40%. Specifically, cucumbers exhibit the lowest import share at 12%, while peppers and tomatoes have higher import shares at 37% and 42%, respectively. Notably, leafy vegetables depend heavily on imports, accounting for 96% of their supply.

Figure 6. Share of domestic cultivation of greenhouse vegetables and imports, 2023



Source: Researcher's estimate based on NSO and Mongolian Customs General Administration statistics

However, it should be noted that the aforementioned estimate excludes canned and frozen vegetables that are imported and compete with domestic farmers and producers. Open customs data reveal details about the importation of canned tomatoes, whereas other vegetables, including cucumbers, peppers, and leafy vegetables, fall under the broader category of canned vegetables, fruits, nuts, and other canned or frozen varieties. Incorporating these semi-finished products into the analysis would elevate the share of imports previously mentioned.

This analysis highlights significant potential for increasing domestic cultivation of vegetables, particularly leafy vegetables and tomatoes, and consequently reducing reliance on imports.

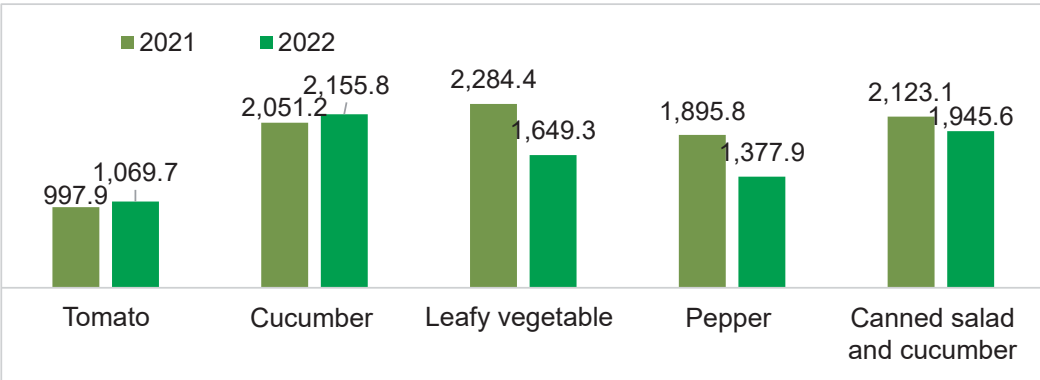
4. DOMESTIC DEMAND FOR GREENHOUSE VEGETABLES

4.1. Consumption of greenhouse vegetables by households

Based on data from the 2021-2023 Household Socio-Economic Survey (HSES) conducted by the NSO[2], it was observed that households across Mongolia collectively consumed approximately 1,000 tons of tomatoes and 2,000 tons of cucumbers annually, with consumption showing a moderate increase of 5-7%. However, the consumption patterns of leafy vegetables (such as lettuce, cauliflower, parsley, and spinach) and peppers exhibited significant variability. Specifically, consumption of leafy vegetables decreased from 2,284 tons to 1,649 tons, while pepper consumption declined from 1,896 tons to 1,378 tons. Additionally, the consumption of packaged salad and canned cucumbers decreased from 2,123 tons to 1,946 tons.

Households consume twice as many cucumbers as tomatoes, yet the overall consumption of these greenhouse vegetables remains low. For instance, according to the HSES data, while households consumed a total of 121,000 tons of other vegetables such as potatoes, carrots, cabbage, and onions in 2021 and 119,000 tons in 2022, the annual consumption of the greenhouse vegetables under consideration amounts to only 8-9 thousand tons.

Figure 7. Annual consumption of greenhouse vegetables by all households, tons



Source: Estimates by researchers based on HSES data from the NSO

In 2021, households purchased 94% of tomatoes and cucumbers, which decreased to 91% in 2022. For leafy vegetables, households purchased 99% of the total consumption in 2021 and decreased slightly to 96% in 2022. Similarly, peppers were purchased 100% and 99% by households in 2021 and 2022, respectively.

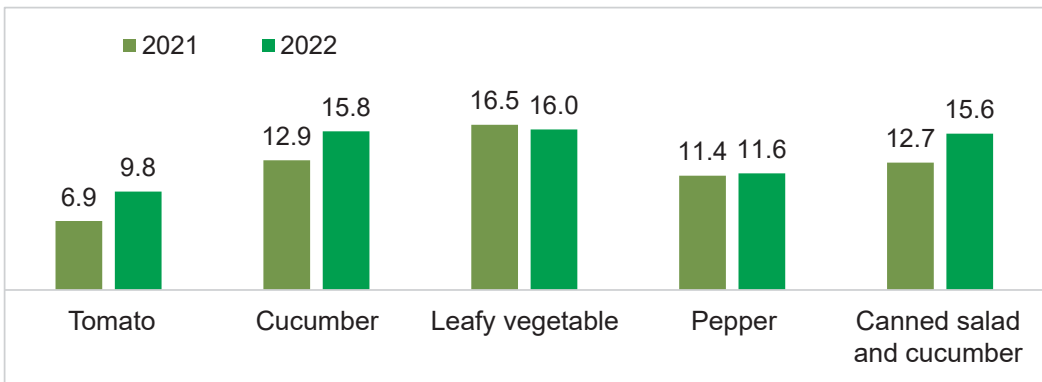
2 In 2021 and 2022, the household weight of the sample survey of was used to calculate the consumption of all households. In other words, the results presented in this chapter represent 920.2 thousand households in 2021 and 941.5 thousand households in 2022.

The remaining portion of greenhouse vegetable consumption was supplied from their own harvests.

Figure 8 shows the total purchase of greenhouse vegetables by households. Households spent a total of MNT 60.3 billion in 2021 and MNT 68.9 billion in 2022 on these greenhouse vegetables. Households spent MNT 203.8 billion in 2021 and MNT 280.5 billion in 2022 on other vegetables. This means that households spent 22.8% of their total vegetable expenditure on greenhouse vegetables in 2021 and 19.7% in 2022.

By category, spending on tomatoes increased by 43% year-over-year in 2022, while spending on cucumbers increased by 23%, peppers by 3%, and canned cucumbers and salads by 23%. However, expenditures on leafy vegetables decreased by 3%.

Figure 8. The amount of annual consumption of greenhouse vegetables by all households, in MNT billion

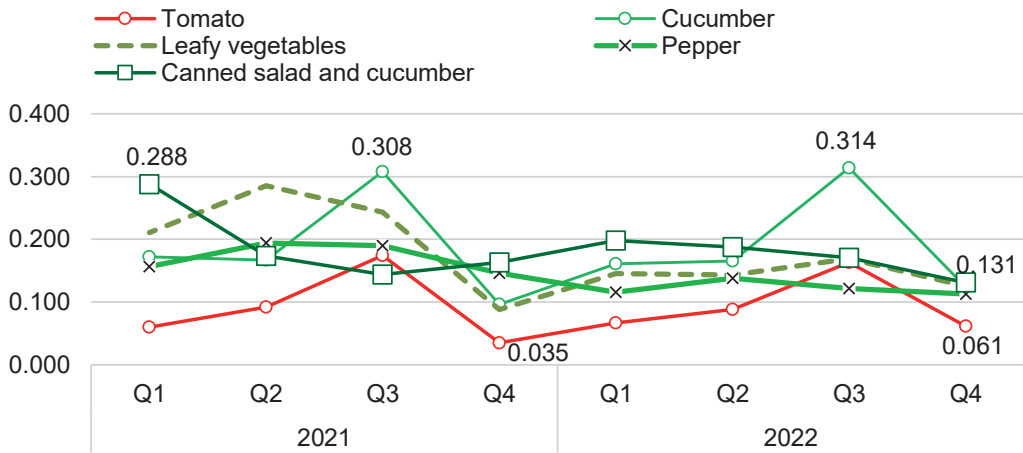


Source: Estimates by researchers based on HSES data from the NSO

Given the changes in vegetable consumption detailed in Figure 7, the substantial increase in purchasing costs suggests a significant rise in vegetable prices in 2022. Particularly notable were the sharp price increases for leafy vegetables, peppers, and canned cucumbers and salads. In response, households attempted to reduce their purchase quantities to mitigate the growth in their expenditures.

When examining the monthly vegetable consumption of households-specifically leafy vegetables, tomatoes, cucumbers, peppers, and canned cucumbers and salads-it is observed that households consume only 100-300 grams of these vegetables per month. However, seasonal fluctuations are noted for certain vegetables (Figure 9). For instance, the consumption of tomatoes and cucumbers peaks in the third quarter of each year and reaches its lowest point in the fourth quarter.

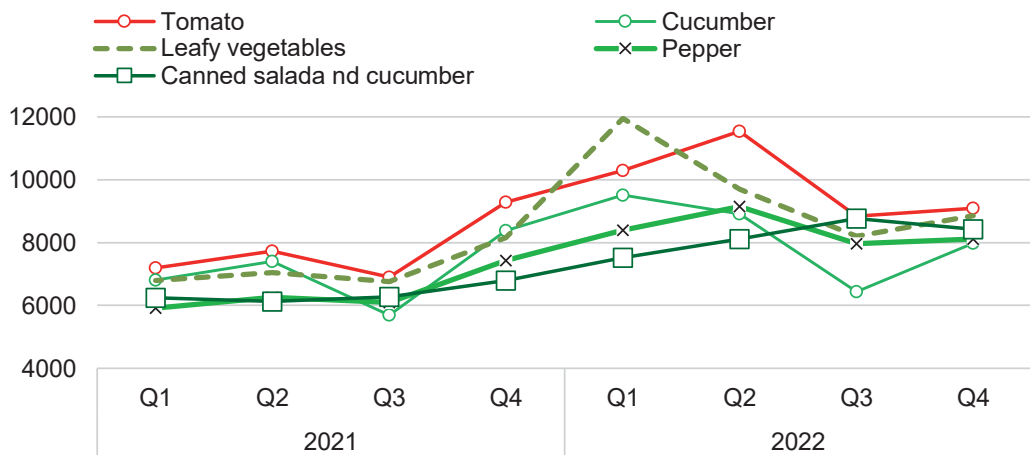
Figure 9. Household consumption of vegetables per month (kg), by quarter



Source: Estimates by researchers based on HSES data from the NSO

Seasonal variations in vegetable consumption are primarily influenced by the supply and pricing of these vegetables. As illustrated in Figure 10, the prices of tomatoes, cucumbers, and leafy vegetables hit their lowest levels in the third quarter of each year, followed by a sharp increase in the fourth quarter and the first quarter of the subsequent year.

Figure 10. Prices of vegetables, MNT per kg, by quarter



Source: Estimates by researchers based on HSES data from the NSO

Figure 10 illustrates a significant increase in vegetable prices in 2022 compared to the previous year. This increase can be attributed to several factors, including delays in the supply of imported vegetables due to ongoing border restrictions during the COVID-19 pandemic and disruptions in the supply of agricultural equipment, seeds, and fertilizers caused by the onset of the Russia-Ukraine war.

The demand for vegetables, including those grown in greenhouses, varies greatly among household groups. Here, we compare market capacity and consumption of vegetables by province and by household income group.

Table 7 compares the total vegetable consumption by households in 2022 across various provinces and the capital city. It is important to note that while the estimations from the NSO's HSES are representative at the provincial level, the consumption of certain low-consumption goods may be calculated differently from the actual figures. Nonetheless, the information in this table is expected to adequately reflect the general proportions of the vegetable market capacity across the provinces.

Table 7. Total household consumption of vegetables (tons), 2022, by province

	Tomato	Cucumber	Leafy vegetables	Pepper	Other
Arkhangai	1.5	15.9	5.7	5.6	2,865.8
Bayan-Ulgii	6.8	20.1	0.5	4.2	3,350.7
Bayankhogor	1.0	1.1	5.2	9.6	2,774.1
Bulgan	2.3	26.9	4.2	4.2	2,265.5
Govi-Altai	5.4	5.2	0.2	7.1	1,692.9
Dornogovi	17.6	62.2	13.8	31.7	3,130.5
Dornod	22.9	41.5	11.3	33.8	3,325.1
Dundgovi	6.1	5.0	6.3	6.2	1,677.3
Zavhan	2.3	21.2	4.8	5.4	2,573.3
Uvurkhangai	6.5	27.4	2.9	33.4	3,247.9
Umnugovi	47.8	88.8	14.4	185.1	3,855.8
Sukhbaatar	4.1	19.3	4.8	10.5	1,936.6
Selenge	2.6	18.2	6.6	16.1	4,582.8
Tuv	9.0	36.5	7.5	16.0	4,289.5
Uvs	1.7	5.6	1.2	7.9	2,098.8
Khovd	44.6	27.3	0.6	12.3	3,002.0
Khuvsgul	0.5	15.1	6.9	6.9	3,679.8
Khentii	7.4	35.6	4.8	15.8	2,567.4
Darkhan-Uul	24.7	105.6	22.2	69	4,694.9
Orkhon	53.3	154.1	77.6	68.4	3,865.1
Govisumber	8.3	16.1	8.0	11.1	967.9
Ulaanbaatar	794.2	1,408.3	1,439.8	817.8	56,494.4
Total	**1,070.6**	**2,157.0**	**1,649.3**	**1,378.1**	**118,938.1**

Source: Estimates by researchers based on HSES data from the NSO

As shown in the table, households in Ulaanbaatar consume the majority of vegetables, such as tomatoes, cucumbers, leafy vegetables, and peppers. Following Ulaanbaatar, the provinces of Orkhon, Umnogovi, Darkhan-Uul, Dornod, and Dornogovi also have relatively high consumption. This indicates that greenhouse vegetables are largely consumed in the capital and major cities with large populations, as well as in provinces close to bigger markets or those with many households that grow greenhouse vegetables. However, it is noteworthy that in Selenge province, the main agricultural region, the consumption of other vegetables is high, while the consumption of greenhouse vegetables is relatively low.

Table 8 illustrates the purchase of vegetables in monetary terms, comparing the total market capacity across provinces. This is directly related to the consumption quantities of vegetables shown in the previous table. For instance, the majority of vegetable sales occurred in the capital city. In 2022, households nationwide spent a total of MNT 9.8 billion on tomatoes, with households in the capital accounting for MNT 8.0 billion of this amount. Out of the MNT 15.8 billion spent on cucumbers, MNT 11.5 billion was spent by households in the capital. For leafy vegetables, out of the total MNT 16.0 billion, MNT 14.2 billion was spent in the capital. Households in the capital also spent MNT 7.2 billion out of the total MNT 11.6 billion on peppers and MNT 10.0 billion out of the MNT 15.6 billion on packaged cucumbers and salads.

Table 8. Households' annual purchase of vegetables (MNT million), 2022, by province

	Tomato	Cucumber	Leafy vegetables	Peppers	Pickled cucumber and salad	Other
Arkhangai	15.1	106.1	23.7	39.9	256.5	6,747.6
Bayan-Ulgii	53.0	101.0	2.5	21.2	321.1	6,019.8
Bayankhongor	7.2	8.3	42.6	78.1	182.0	6,734.9
Bulgan	19.2	101.3	25.3	26.9	71.1	4,548.5
Govi-Altai	25.0	41.2	2.1	43.5	66.4	3,692.2
Dornogovi	74.4	314.4	114.6	205.9	503.6	7,501.7
Dornod	98.6	134.0	94.8	308.8	362.6	7,194.6
Dundgovi	46.0	25.0	43.0	45.7	77.9	3,950.2
Zavkhan	24.5	180.8	38.8	45.9	523.9	6,000.7
Uvurkhangai	49.4	154.9	17.9	274.8	76.1	7,112.4
Umnugovi	278.4	497.7	143.1	1,468.9	353.3	10,379.0
Sukhbaatar	34.4	122.8	47.2	91.3	517.8	4,680.4
Selenge	23.4	67.1	32.6	140.1	111.4	9,148.0
Tuv	75.5	244.9	72.2	118.3	335.4	8,178.2

Uvs	10.7	34.1	11.1	49.2	123.6	5,188.1
Khovd	193.1	159.1	0.9	115.7	156.9	5,931.5
Khuvsgul	5.3	112.3	93.2	49.1	105.5	8,256.2
Khentii	37.6	128.3	30.1	119.9	123.3	6,326.5
Darkhan-Uul	174.7	628.6	257.3	496.9	113.9	11,479.0
Orkhon	494.7	1,128.6	679.1	588.0	979.0	9,403.2
Govisumber	57.6	103.8	72.0	97.3	167.9	2,154.6
Ulaanbaatar	8,013.6	11,457.7	14,178.7	7,200.7	10,056.4	139,851.1
Total	**9,811.4**	**15,852.0**	**16,022.8**	**11,626.1**	**15,585.6**	**280,478.4**

Source: Estimates by researchers based on HSES data from the NSO

Households in cities and towns may consume more expensive greenhouse vegetables due to their higher household income. To clarify this, Table 9 shows the average consumption of greenhouse vegetables by household income groups. Households are divided into five equal groups based on their income level, and the average monthly purchase amount of each group is expressed in monetary terms. As can be seen from the table, the higher the household income, the more money was spent on buying vegetables. In particular, the cost of greenhouse vegetables correlates even more strongly with the level of income. Among households in all income groups, many do not buy these greenhouse vegetables, but as the income of the household increases, the tendency to buy greenhouse vegetables also increases.

Table 9. Household's average monthly vegetable purchases (gross), 2022, by income group

	Tomato	Cucumber	Leafy vegetables	Pepper	Pickled cucumber and salad	Other
Poor	166	338	403	353	439	15,801
Below middle	347	627	782	667	803	21,331
Middle	593	1,059	982	923	1,161	24,924
Above middle	803	1,489	1,692	1,195	1,563	28,708
Wealthy	2,430	3,499	3,233	2,007	2,932	33,366

Source: Estimates by researchers based on HSES data from the NSO

For example, households in the poorest 20% spend an average of only MNT 166 per month on tomatoes, while households in the richest 20% spend MNT 2,430. For cucumbers, these amounts are MNT 338 and 3,499, respectively. For leafy vegetables, the expenditure is MNT 403 for the poorest and MNT 3,233 for the richest. For peppers, it is MNT 353 and MNT 2,007, and for pickled cucumbers and salads, it is MNT 439 and 2,932. However, for other vegetables, the expenditure

gap between poor and wealthy households is narrower, with expenses of MNT 15,801 and 33,366, respectively.

4.2. Demand for greenhouse vegetables in the catering industry

An important factor in the vegetable value chain is the caterer and restaurant. However, there are currently no aggregated statistics on vegetable and fruit consumption within this sector. To address this gap, this study interviewed a small sample of enterprises, including food chain restaurants, large offices, schools, kindergartens, and vegetable markets, to assess their demand for greenhouse vegetables.

Surveyed large restaurants or chain restaurants and cafeterias in large factories and group companies reported an average weekly vegetable consumption of one ton. Smaller restaurants, on average, consumed 80 kilograms of vegetables per week. It is essential to note that these figures represent averages from a limited sample size.

Table 10. Weekly consumption of vegetables for some restaurants and caterers, kg

	Large restaurant	Small restaurant
Cucumber	425	21
Tomato	350	22
Leafy vegetables	180	17
Pepper	60	19
TOTAL	**1,015**	**79**

Source: Interview with caterers and restaurants by research team

Vegetables, a key ingredient in their food preparation, are typically sourced from food markets and wholesale centers. Large rural restaurants often purchase imported vegetables from markets such as “Mercury” and “Bars” in Ulaanbaatar. However, most restaurants in Ulaanbaatar primarily buy their vegetables from the “Bars” market. Large restaurants frequently work directly with vegetable growers or intermediary companies. Additionally, there are vendors who deliver vegetables to most restaurants (ERI, 2019).

Restaurants and eateries primarily purchase vegetables from food markets and wholesale centers. While large rural restaurants often order imported vegetables directly from Ulaanbaatar markets like “Bars” or purchase them independently, many establish direct partnerships with vegetable growers or intermediary companies. Additionally, dedicated vendors supply vegetables to some restaurants.

Retailers and individuals import vegetables weekly for resale to restaurants and other businesses. Importers and wholesalers prioritize the rapid sale and delivery of greenhouse vegetables to large restaurants due to the perishable nature of

these products and limited storage capacity.

Despite a preference for local produce, restaurants face challenges due to seasonal supply fluctuations. Domestic vegetable production peaks in July and August but declines sharply during winter and spring, leading to supply shortages and price increases. As a result, the sale of imported vegetables dominates the market.

Restaurants that participated in this research purchase necessary vegetables directly from the farmers in the following ways. It includes:

- Go to the farmers, negotiate the price, and check the quality. In doing so, no contract is made.
- Or work together by signing a contract. According to the contract, vegetables are purchased in advance, and the calculation is done at the end of the month. Returns are possible, and the vegetables are delivered by the supplier. In doing so, they are differentiated by quality and quantity.
- There are also cases of cooperating with the same farmer for a long time and buying vegetables.
- Cooperates with companies that grow their own crops.

Restaurants that wish to purchase vegetables directly from farmers typically have the following requirements:

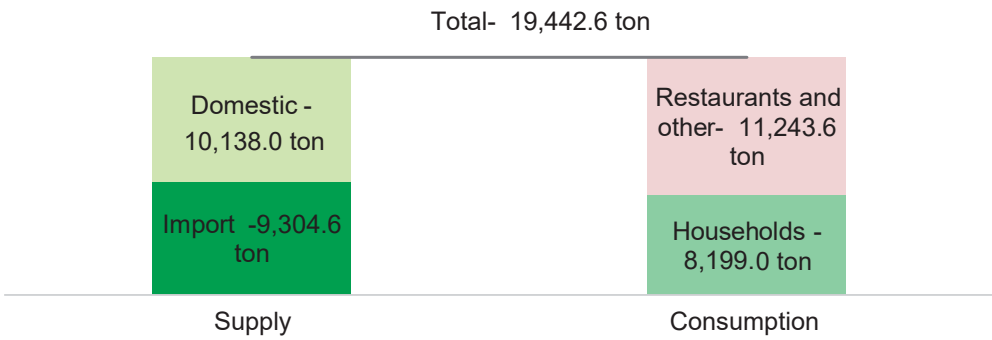
- Fresh, healthy, and intact produce
- Regular and timely deliveries
- Fixed prices, irrespective of seasonal changes
- Consistent availability
- Proper storage procedures, ensuring no violations
- Reasonable pricing
- Availability of refunds
- Clear documentation of origin
- Provision of financial documents
- Uniform and standard-sized produce

5. EQUILIBRIUM IN THE GREENHOUSE VEGETABLE MARKET

5.1. Equilibrium in the Greenhouse Vegetable Market

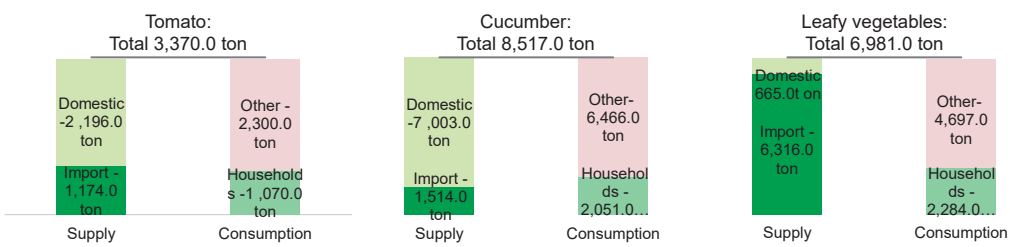
From the supply and consumption data of greenhouse vegetables presented in the previous chapters, we can express the domestic market ratio as follows (Figure 11). Based on available data for supply and consumption in 2022, 19.4 thousand tons of greenhouse vegetables were supplied domestically. Of this total, 10.1 thousand tons (more than half) originated from domestic cultivation, while the remaining 9.3 thousand tons were imported. Households consumed 8.2 thousand tons of these vegetables in their unprocessed form directly for food. The remaining 11.2 thousand tons were utilized by the catering industry and used in the production of processed products like canned salads and cucumbers. In addition, a portion of the total vegetable supply was lost due to post-harvest waste.

Figure 11. Supply and consumption of all greenhouse vegetables in 2022



Source: Estimates by researchers based on HSES raw data and crop statistics from the NSO and import statistics from MCGA

Figure 12. Supply and consumption of all greenhouse vegetables in 2022, by variety of vegetable



Source: Estimates by researchers based on HSES raw data and crop statistics from the NSO and import statistics from MCGA

The supply and consumption ratio can be further analyzed by disaggregating the data into specific greenhouse vegetable varieties. Figure 12 presents a detailed breakdown of the supply and consumption of tomatoes, cucumbers, and leafy vegetables. However, inconsistencies in data availability prevented a similar analysis for peppers. Given that reported household pepper consumption exceeds the total supply, including imports, a thorough examination of pepper import data is warranted.

Market supply and demand dynamics can be inferred from price fluctuations. The following section examines price analysis to show recent trends in vegetable surpluses and shortages in the domestic market.

5.2. Price Analysis

5.2.1. Producer prices

The UN Food and Agriculture Organization (FAO) database includes annual producer prices for various vegetable varieties in Mongolia. However, these prices significantly diverged from those estimated through sample surveys of farming households. Consequently, this study utilized survey data from the NSO and other relevant sources instead of relying on FAO data.

This study utilized data from 65 tomato-producing and 103 cucumber-producing households participating in the 2021-2023 Household Socio-Economic Survey (HSES). For each vegetable, we calculated the average (median) producer price for the specified period (Table 11). Due to insufficient detail in the HSES data, prices for peppers and leafy vegetables are not included in the table.

Table 11. Median producer prices of vegetables, MNT per kg

	2021	2022	2023
Tomato	4,000	5,000	5,000
Cucumber	2,000	3,500	5,000

Source: Researchers' calculation based on the sub-sample of farmer households in HSES

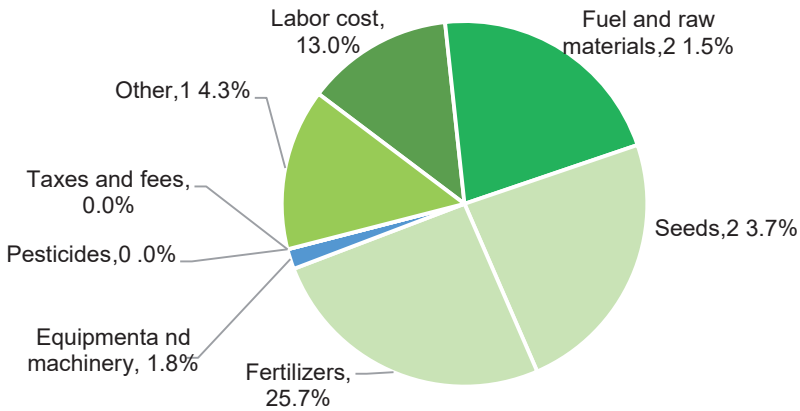
A critical aspect of producer price analysis involves determining the ratio of intermediate consumption to surplus value within that price. The 2015 NSO detailed sample survey indicated that crop production's added cost constituted 50.9% of the total (NSO, 2016). However, this calculation aggregated households cultivating crops and fodder plants with those growing vegetables.

To isolate the cost structure of greenhouse farming, this study adopted a similar methodology using a subset of cucumber and tomato-producing households from the 2022 NSO data. These households reported an average annual greenhouse farming sales income of MNT 1,030,000 and expenses of MNT 614,450 in 2022.

Figure 13 illustrates the resulting cost structure for these household farmers. The majority of expenses were allocated to fertilizers (25.7%), seeds (23.7%), fuel, and

other raw materials (23.8%), with labor costs (wages and salaries) accounting for 13.0%. Notably, the surveyed farmers reported incurring no tax fees or expenses related to pest control.

Figure 13. The cost structure of vegetable production in household farms, 2022



Source: Researchers' estimation based on NSO HSES-2022 raw data

Among the aforementioned costs, wages and taxes are categorized as value-added components for vegetable growers. Additionally, the profit or loss generated from household agricultural production is considered value-added. In aggregate, intermediate consumption for vegetable-producing households in 2022 amounted to 51.9% of total production costs. The remaining 48.1% constitutes value-added, comprising 7.8% for wages and 40.3% for farmers' profit.

While the preceding analysis is based on national-level data, the calculated value-added pertains to total household production and does not provide a granular breakdown for individual vegetable varieties. There is a lack of recent, publicly accessible studies examining the value-added for specific vegetables at the national level. Although the SECiM project's 2018 report, titled "Export and import of agricultural products of Mongolia: integration with the value chain," presents regional-level findings (SECiM, 2018), it does not delve into the cost structure of greenhouse vegetables like tomatoes and cucumbers.

A qualitative survey conducted by the Economic Research Institute in 2019 gathered information from greenhouse vegetable-producing households (ERI, 2019). The study focused on farmers from Mandal Soum, Selenge Province, and Selenge Soum, Bulgan Province. Participants cultivated vegetables for an average of 18 years (range: 4-26 years) and farmed an average of 2.8 hectares (range: 1-7 hectares). Additionally, the survey found that farmers employed an average of three workers during the summer, twelve in autumn, and five in spring, supplementing labor with family members. Table 12 presents detailed information

on greenhouse utilization provided by these farmers.

Table 12. Use of greenhouses and storage facilities

Number of survey participants	11
Number of greenhouse farmers	9 (7 with ordinary greenhouses /in duplicate/, 3 with equipped greenhouses)
Area of greenhouse	Minimum – 12 m^2 Maximum – 3,760 m^2 Average – 680 m^2
Funding sources for greenhouse setup	7 of the 9 farmers used personal funds, 3 obtained financial aid from projects/ programs, and 1 relied on rental support (in duplicate).
Annual average cost for running a greenhouse farm.	MNT 937,890

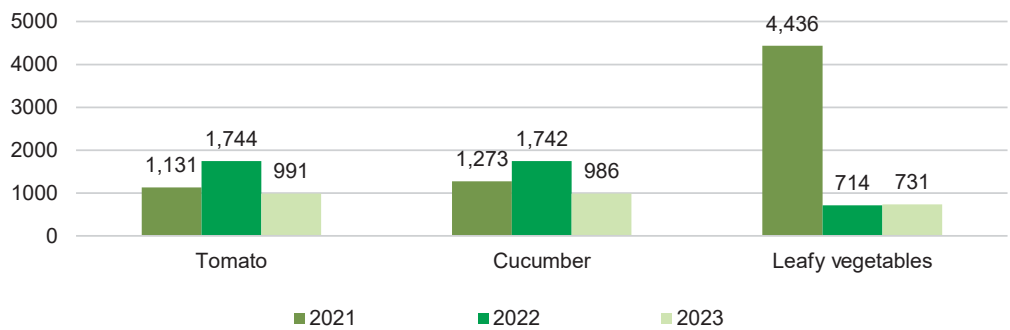
Source: Economic Research Institute-2019

However, the data presented above pertains to 2019 and requires updating to reflect current cost information.

5.2.2. Import prices

The import price of vegetables is primarily influenced by two factors: the market price of vegetables in China, Mongolia's primary supplier, and the exchange rate. Figure 14 illustrates the fluctuation of vegetable import prices in recent years.

Figure 14. Average import prices of vegetables, MNT per kg



Note: The average import price is calculated by dividing the total value of imported vegetables by the total imported quantity.

Source: Mongolian Custom General Administration

The figure shows that the price trends for tomatoes and cucumbers exhibit a similar pattern. Both vegetables experienced price increases in 2022 primarily

due to transportation and logistics disruptions coupled with global food price inflation. Subsequently, prices for these commodities declined sharply in 2023.

In addition to the factors mentioned above, import tariffs play an important part in influencing import prices. Mongolia imposes the following two types of taxes on imported vegetables.

(i) (i) Customs tax: A 20% tax is imposed on imports of potatoes, cabbage, yellow carrots, rutabagas, tomatoes, and other key vegetables that are also produced domestically. A 15% tax is imposed on imports of green onions and other varieties of onions. A 5% tax is imposed on the imports of other vegetables, including root vegetables and tubers.

(ii) (ii) According to Mongolian tax laws, while vegetables produced and sold domestically are exempt from VAT, imported vegetables are subject to a VAT at a rate of 10% of their sales value.

A comparison of producer and importer prices, as calculated in the previous section, reveals an interesting pattern (Table 13).

Table 13. Producers' prices vs. Importers' prices (MNT per kg), 2023

	Producers' average price*	Import average price**
Tomato	5,000	991
Cucumber	5,000	986
Leafy vegetable	-	731

*Source: Researchers' calculation based on * - HSES-2023 raw data, NSO and ** - MCGA statistics*

Despite discrepancies in data sources and calculation methodologies, a clear trend emerges from the comparison. Import prices declared at customs are significantly lower (approximately 80%) than those charged by domestic farmers. While customs duties, value-added taxes, and transportation costs would increase the final import price, the disparity highlights the substantial challenge domestic producers face in competing with imported products on price.

5.2.3. Consumer prices

Vegetable prices are primarily influenced by market supply and consumer purchasing power, with long-term trends generally aligning with overall price inflation. Table 14 presents median consumer prices for various vegetables over the past three years. A significant price increase was observed in 2022, followed by a slight decline in 2023.

Table 14. Median prices paid by consumers, MNT per kg

	2021	2022	2023
Tomato	7,500	10,000	8,500
Cucumber	7,000	8,083	8,000
Leafy vegetables	7,000	9,000	8,000
Pepper	6,500	8,800	8,000

Source: Researchers' calculation based on HSES raw data of NSO

Comparing these consumer prices to the producer prices calculated previously, the final column of Table 15 presents the percentage difference between the two. This analysis indicates that the price of tomatoes increases by 70% from the producer to the consumer level, while cucumbers exhibit a 60% price increase.

Table 15. Comparison of producer and consumer prices for vegetables, MNT, 2023

	Producer price, MNT per kg	Consumer price, MNT per kg	Consumer price difference, %
Tomato	5,000	8,500	70%
Cucumber	5,000	8,000	60%
Leafy vegetables	-	8,000	-

Source: Researchers' calculation based on HSES raw data of NSO

6. PROFITABILITY OF GREENHOUSE FARM

6.1. Current situation of greenhouse farmers

Currently, the primary policy supporting greenhouse farming is Resolution No. 36, "Some Measures to Ensure Food Supply and Security," approved by the Parliament in 2022. This resolution mandates an increase in greenhouse area to 270 hectares by 2026, with specific targets of 188 hectares for summer greenhouses and 82 hectares for winter greenhouses (up from 88 and 32 hectares, respectively). To incentivize greenhouse construction, enterprises, and individuals are eligible for subsidized loans with a 5-6% interest rate, with the government allocating MNT 39 billion in interest subsidies from 2022 to 2026.

According to the Ministry of Food, Agriculture, and Light Industry (MOFALI), the project implementation began in April 2023. By the end of that year, commercial banks had issued MNT 11.8 billion in subsidized loans to 22 entities (15 in Ulaanbaatar, 3 in Selenge Province) for greenhouses. These loans feature a five-year term, a 5% annual interest rate, and a 12-month principal payment grace period.

The government plans to allocate an additional MNT 7 billion in subsidized loans for greenhouse development in 2024.

This study conducted in-depth interviews with 15 greenhouse farming enterprises and individuals located near Ulaanbaatar to gather additional insights. Greenhouse farmers identified several key challenges:

- **Human resource constraints:** A shortage of qualified agrotechnical workers hinders optimal greenhouse management, leading to potential productivity losses for farmers with limited knowledge.
- Consumer awareness and demand: Low consumer awareness of the nutritional benefits of greenhouse vegetables and limited purchasing power constrain overall demand.
- **Storage limitations:** The absence of dedicated storage facilities, particularly following the peak harvest period in July (Naadam), necessitates immediate sales at discounted prices. The concentration of summer greenhouses leads to oversupply and price competition in August and September.
- **High winter greenhouse costs:** The short winter daylight hours and substantial heating requirements, primarily reliant on electricity, increase production costs for winter greenhouses. Power outages pose a significant risk of crop loss. Additionally, limited snow removal and lighting technologies further constrain winter production.
- **Technological gaps:** The lack of automated systems for controlling soil, air temperature, humidity, fertilizers, and pest management hinders efficient greenhouse operations.

- **Import competition:** Imported vegetables, often treated with chemicals for extended shelf life, pose a significant challenge to domestically produced, organic products. Perishable organic produce requires rapid sales to minimize waste.
- **Financial constraints:** High-interest commercial loans and limited access to long-term, subsidized financing hinder greenhouse investment.

Beyond these operational challenges, experts highlighted farmers' limited financial management capabilities. Numerous greenhouse ventures have failed due to inadequate planning and financial analysis. To address this issue, this study develops a user-friendly financial model for small and medium-sized greenhouse enterprises. The model is detailed in the following section.

6.2. A basic financial model for greenhouse

When building a small-scale greenhouse for cucumbers and tomatoes, a basic financial model should consider the following factors.

Costs:

- Greenhouse structure. This includes materials (framing, roofing, etc.) and construction labor. Costs vary depending on size, design, and materials used. Consider using recycled or readily available materials to bring costs down.
- Climate control system (optional). Depending on your location and desired level of control, you may need heating, cooling, or ventilation systems.
- Seeds and seedlings. Factor in the cost of seeds or seedlings for your chosen vegetables.
- Growing media. This could include soil, soilless mixes, or hydroponic systems.
- Fertilizers and pest control. Budget for nutrients to keep your plants thriving and pest control measures to minimize crop loss.
- Water supply. Consider the cost of installing a watering system (drip irrigation is common in greenhouses) and the ongoing cost of water usage.
- Tools and equipment. You'll need basic gardening tools and may require specific equipment depending on your chosen growing setup.

Revenue:

- Selling your produce. Study local market prices for cucumbers and tomatoes to estimate your potential income. Consider factors like seasonality, transport cost, and selling directly to consumers (farmers' markets) versus wholesale.
- Market competition and capacity. It is necessary to know about the characteristics of the wholesale and retail markets of the province or city, the number of consumers and competitors, and the market capacity.

Break-even analysis:

Calculate your break-even point to determine how much you need to sell to cover your costs. This will help you estimate how long it will take to recoup your initial

investment and turn a profit.

Additional factors:

- Land lease or ownership. Factor in the cost of leasing or owning the land where the greenhouse will be situated.
- Labor. Consider the cost of your own time or hiring labor to help manage the greenhouse.
- Permits and licenses. Research any local requirements for permits or licenses to operate a greenhouse business.

Financial calculation of greenhouse farming

Based on this study's findings, a simplified financial model for greenhouse farming was developed and implemented in an MS Excel template to estimate business profitability. The template comprises five primary components:

The template comprises five primary components:

1. Description: Provides an overview of the model, its underlying assumptions, and a summary of each worksheet.
2. Assumptions: Outlines project details, economic forecasts, and financing information derived from the greenhouse farmer survey and supplementary data. Users can modify these parameters to conduct scenario analyses.
3. Cash Flow: The core financial calculation section.
    - It determines project income, expenses, taxes, loan payments, and net profit based on assumptions in the "Assumptions" sheet.
    - Revenue is calculated considering greenhouse area, crop type, yield, and selling price.
    - Costs are estimated based on greenhouse size, crop volume, and unit costs, including labor (one employee per 300m²).
    - Income and expenses are projected to increase annually in line with average inflation, although alternative assumptions can be applied.
    - The model incorporates corporate income tax and a loan financing structure for greenhouse construction, with working capital provided by the farmer.
    - Free cash flow is derived by subtracting expenses, taxes, and loan repayments from annual income.
    - Net profit is calculated by deducting depreciation from free cash flow.
4. Loan Repayment: Details loan repayment based on the financed portion of greenhouse construction costs, interest rate, loan term, and equal installment repayment method.
5. Sensitivity Analysis: Presents tabular and graphical representations of how changes in tomato and cucumber prices impact income and free cash flow.

This financial model offers a practical tool for greenhouse farmers to assess the financial viability of their operations.

Example 1. Building a 200m² SUMMER greenhouse.

A 200 m² summer greenhouse requires an initial investment of MNT 20 million,

financed through a three-year commercial bank loan at a 17% interest rate. Annual loan repayments amount to MNT 9.1 million.

Summer greenhouse vegetables, primarily cucumbers (priced at MNT 6,200) and tomatoes (priced at MNT 7,900), are typically sold in the third quarter when prices are relatively low. Assuming equal cultivation areas for both crops, the first-year revenue is estimated at MNT 16.9 million, with subsequent increases based on anticipated price inflation.

The farmer bears all operational costs, including labor (one employee) and other expenses aligned with summer greenhouse standards. Initial operational costs for the May-to-October growing season are estimated at MNT 8.5 million, with subsequent increases due to inflation.

Given the loan repayment schedule and greenhouse depreciation, profits are deferred until the fourth year.

Over a ten-year project horizon, the present value of cash flows is estimated at MNT 30 million.

Example 2. Building a 200m^2 WINTER greenhouse.

A 200 m² winter greenhouse requires an initial investment of MNT 86 million, financed through a three-year commercial bank loan at a 17% interest rate. Annual loan repayments amount to MNT 38.9 million.

Winter greenhouse production targets the second, third, and fourth quarters, benefiting from higher winter vegetable prices (cucumbers at MNT 9,400 and tomatoes at MNT 9,800) compared to summer prices (cucumbers at MNT 6,200 and tomatoes at MNT 7,900). Assuming equal cultivation areas for both crops, first-year revenue is estimated at MNT 40 million, with subsequent increases based on anticipated price inflation.

The farmer bears all operational costs, including labor (one employee) and expenses aligned with winter greenhouse standards. Initial operational costs for the March-to-December growing season are estimated at MNT 17.5 million, with subsequent increases due to inflation.

Due to significant loan repayments and depreciation costs, profitability is deferred for six years. While loan repayment is completed in the fourth year, profit generation commences in the seventh year after recovering prior losses.

The present value of the ten-year project's cash flow is estimated at MNT 47.7 million.

7. CONCLUSION

More than 4,500 households and more than 400 enterprises are utilizing 88 hectares of summer greenhouses and 32 hectares of winter greenhouses nationwide. The capital city, Tuv, and Selenge provinces cultivate the largest greenhouse areas. Over half of all winter greenhouses are in the capital due to its centralized power supply and market proximity.

Cucumbers, tomatoes, and leafy vegetables are the primary greenhouse crops. In 2023, 8,500 tons of cucumbers and 2,160 tons of tomatoes were harvested. Cucumbers comprise approximately 60% of the greenhouse vegetable yield and have exhibited increasing production in recent years. Leafy vegetable cultivation, although relatively small-scale, is expanding rapidly, while tomato production has remained relatively stable. Selenge, Darkhan-Uul, Khovd, and Ulaanbaatar provinces lead greenhouse vegetable cultivation.

Greenhouse vegetable supply is heavily reliant on imports. As of 2023, imports constitute 60% of the total supply, with domestic production accounting for the remaining 40%. Cucumbers exhibit the lowest import share at 12%, while peppers and tomatoes have import shares of 37% and 42%, respectively. Leafy vegetables demonstrate an almost complete dependence on imports, with a 96% import share.

42% of the total vegetable supply is consumed directly by households, while the remaining 58% is utilized by the catering industry, processed into products like canned salads, or lost to waste. Households consume approximately 1,000 tons of tomatoes and 2,000 tons of cucumbers for direct consumption. Additionally, households consume 1,650 tons of leafy vegetables, 1,380 tons of peppers, and 1,950 tons of packaged salads and canned cucumbers. However, there is a dearth of statistical data regarding greenhouse vegetable consumption within the catering sector.

52% of greenhouse vegetable farmers' selling price or cost is attributed to inputs and raw materials, with wages accounting for 7.8% and farmers' profit constituting 40.3%. Conversely, import prices declared at customs are significantly lower—approximately 80% lower—than those charged by domestic farmers. Although customs duties, value-added taxes, transportation costs, and trade profits inflate import prices, domestic farmers remain at a competitive disadvantage.

Furthermore, the selling price realized by farmers is notably lower than the final consumer price due to the complexities and costs associated with transporting greenhouse crops to market. For instance, tomato prices increase by up to 70% from the farm gate to the consumer, while cucumber prices rise by up to 60%. The concentration of greenhouse cultivation in the summer months exacerbates

this issue, leading to oversupply, price declines, and reduced farmer revenue in the third quarter.

Greenhouse farmers have identified several key challenges:

- Shortage of skilled labor and support personnel.
- Limited household demand and consumption of greenhouse vegetables.
- A dearth of dedicated storage facilities.
- High costs and technological limitations associated with winter greenhouse cultivation.
- Intense import competition.
- Restricted access to affordable, long-term financing.

Financial model analysis indicates that summer greenhouse investments tend to have lower startup costs and the potential for profitability within three years under favorable market conditions. Winter greenhouse projects, on the other hand, require substantial initial investments and may defer profit generation until the seventh year. However, these projections are sensitive to operational expenses, loan terms, and market prices.

REFERENCE

Development Solutions. (2023). Хөдөө аж ахуйн бизнесийн нэмүү өртгийн сүлжээг үнэлэх нь. Улаанбаатар: Хөгжлийн шийдэл.

ERI. (2019). Data Collection Study for the Master Plan of Developing Value Chain in Agriculture. Ulaanbaatar: JICA.

GIZ. (2023a). Өвлийн хүлэмжийн бизнес төлөвлөгөө боловсруулах гарын авлага. Улаанбаатар: Deutsche Gesellschaft für Internationale Zusammenarbeit.

GIZ. (2023b). Өвлийн нарлаг хүлэмж байгуулалтын технологийн гарын авлага. Улаанбаатар: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

NSO. (2016). Agricultural Sample Survey - 2015. Ulaanbaatar: National Statisitics Office.

SECiM. (2018). “Монгол Улсын ХАА-н гаралтай бүтээгдэхүүний экспорт, импорт: үнэ цэний сүлжээтэй уялдах нь”.