

Production and Market of Glycine in China

The Eleventh Edition

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Researched & Prepared by:

Kcomber Inc.

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Executive summary

China is one of the major production countries of glycine in the world, and four grades of glycine are produced here, namely tech-grade, food-grade, feed-grade and pharmaceutical-grade.

Currently, almost all Chinese glycine producers adopt chloroacetic acid ammonolysis process, but Guang'an Chengxin (formerly Guang'an Chengyang) adopts the Hydantion process, whose glycine production lines were built up in Nov. 2015.

Both the capacity and output of glycine in China kept increasing during 2014–2021, along with steady development of glyphosate (glycine's key end use segment) in China. Output of the tech-, feed- and food-grade glycine increased in this period in general.

National capacity of tech-grade glycine increased from 347,000 t/a in 2014 to 603,000 t/a in 2021, and its output increased from less than 250,000 tonnes to 352,500 tonnes in this period. However, China's glycine industry has often witnessed overcapacity in the past few years, and this situation will not change much in the coming few years.

China's glycine production is highly concentrated, while its upstream industries including both chloroacetic acid and urotropine are not. Hebei Donghua is the top glycine producer in China and even in Asia. In 2021, its tech-grade capacity accounted for nearly 32% of the national total.

Some glyphosate producers have built up glycine production lines for their glyphosate technical production.

- Hubei Trisun's 100,000 t/a glycine: firstly supplied to itself, and the rest sold to others
- Fuhua Tongda's 40,000 t/a glycine: mainly consumed by itself
- Inner Mongolia Xingfa's 10,000 t/a glycine: consumed by itself
- Henan HDF's 15,000 t/a glycine: mainly consumed by itself

The price of glycine is closely linked with that of glyphosate (high positive correlation), because of glycine's limited consumption fields and simple production technology. In 2021, glycine was in short supply due to a number of factors, including COVID-19, domestic power rationing, soaring raw material cost, and reduced glyphosate supply overseas under hurricane attack. At the end of 2021, the price of glycine hit a ten-year record high at USD5,495/t. However, the price fell rapidly in H1 2022, going down to USD2,776/t by June.

China's total export volume of glycine increased on the whole in 2014–2021, rising from 25,896 tonnes in 2014 to an estimated 61,342 tonnes in 2021. Food-grade glycine is the main product in China's glycine export, with its export volume accounting for 76%–79% of the total glycine export volume during 2019–2021. China started to export tech-grade glycine in 2018, with 3,688 tonnes, accounting for 6.7% of total export volume that year. In 2021, the export volume of tech-grade glycine is expected to be 5,606 tonnes, 9.1% to the whole.

Quite different from the overseas consumption structure, the largest end-use segment of glycine in China is glyphosate. The output of glycine route glyphosate reached 449,000 tonnes in 2021, consuming about 261,000 tonnes of glycine in total, which means around 75.2% of tech-grade glycine was applied in the domestic glyphosate industry.

The consumption of food-, feed- and pharmaceutical-grade glycine all increased from 2014 to 2021, with their CAGR in this period at 3.8%, 4.6% and 4.1% respectively.

Methodology

- Research objectives

Objectives of this research are to present an in-depth and comprehensive view of Chinese glycine market. CCM's goal of this research is to determine the current status of Chinese glycine industry and assess its growth potential from 2022 to 2026.

Having accumulated profound understanding on industrial chains of glyphosate, the most important downstream industry of glycine, CCM will present an insight into glycine market and future trends, together with its industry structure, including upstream products, applications. A review of glycine's competitiveness is also provided in the report.

- Scope of report

All of the four grades of glycine, including tech-grade, food-grade, pharmaceutical-grade and feed-grade, will be investigated in this research.

This report will present industry insights from the following aspects:

- Supply (capacity, output)
- Key players (active producers, potential producers)
- Technology
- Raw materials
- Demand by volume
- Trade
- Price

- Methodology

Telephone Interviews

The interviewees include:

- Producers
- Traders
- Researchers
- Raw material suppliers
- End users

Data processing and presentation

The data collected and compiled were sourced from:

- Published articles from Chinese periodicals, magazines, journals, and third-party databases
- Government statistics & Customs statistics
- Telephone interviews with Chinese producers, traders, end users, etc.
- Comments from industrial experts
- CCM's database
- Professional database from other sources
- Information from the Internet

The data from various channels have been combined to make this report as precise and scientific as possible. Throughout the process, a series of internal discussions were held in order to analyse the data and draw conclusions from it.

Information sources

Sources of desk research are various, including published magazines, journals, government statistics, industry statistics, customs statistics, association seminars as well as information on the internet. A lot of work has been done to compile and analyse the information obtained. When necessary, checks were made with Chinese market players regarding market information such as production, demand, consumption, competition.

Glossary

Abbreviations in this report are listed as follows:

DEA: Diethanolamine

IDAN: Iminodiacetonitrile

HCN: Hydrogen cyanide

CAGR: Compound annual growth rate

GM: Genetically modified

HHI: Herfindahl-Hirschman Index

Unit

tonne: equals to metric ton in this report

/t: per tonne

t/a: tonne/annual, tonne per year

USD: currency unit in the US

RMB: currency unit in China, also named Yuan

Table USD/CNY exchange rate, Jan. 2014–July 2022

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
2014	6.1043	6.1128	6.1358	6.1553	6.1636	6.1557	6.1569	6.1606	6.1528	6.1441	6.1432	6.1238	6.1428
2015	6.1272	6.1339	6.1507	6.1302	6.1143	6.1161	6.1167	6.3056	6.3691	6.3486	6.3666	6.4476	6.2288
2016	6.5527	6.5311	6.5064	6.4762	6.5315	6.5874	6.6774	6.6474	6.6715	6.7442	6.8375	6.9182	6.6425
2017	6.8918	6.8713	6.8932	6.8845	6.8827	6.8019	6.7772	6.7148	6.5909	6.6493	6.6300	6.6067	6.7662
2018	6.5079	6.3045	6.3352	6.2764	6.3670	6.4078	6.6157	6.8293	6.8347	6.8957	6.9670	6.9431	6.6070
2019	6.8482	6.7081	6.6957	6.7193	6.7344	6.8896	6.8716	6.8938	7.0883	7.0726	7.0437	7.0262	6.8826
2020	6.9614	6.9249	6.9811	7.0771	7.0690	7.1315	7.0710	6.9980	6.8498	6.7796	6.7050	6.5921	6.9284
2021	6.5408	6.4623	6.4754	6.5584	6.4895	6.3572	6.4709	6.4660	6.4680	6.4604	6.4192	6.3693	6.4615
2022	6.3794	6.3580	6.3014	6.3509	6.5672	6.6651	6.6863	-	-	-	-	-	-

Source: The People's Bank of China

1 Overview of glycine in China

1.1 Introduction of glycine in China

China is one of the major glycine production countries and the majority of homemade glycine is of tech grade.

China's glycine industry started in 1969. At that time, Hebei Normal University took the initiative to set up the first glycine facility adopting the chloroacetic acid ammonolysis process in China. Later, it transferred the technology to Zhengding Joint Chemical Factory for free, the former of Hebei Donghua Chemical Group.

Commercial production of glycine by the chloroacetic acid ammonolysis process hadn't started until the late 1970s, and this pathway was accessible and the requirement for facilities was relatively low.

Capacity and output of glycine kept increasing in China during 2014–2021, along with steady development of glyphosate (glycine's key end use segment) in China. There is an overall upward trend in the output of tech-, food- and feed-grade glycine.

Table 1.1-1 Supply and demand of glycine in China, 2014–2021

Year	Capacity, t/a		Output, tonne		Export, tonne	Apparent consumption, tonne	
	Tech-grade	Others	Export, tonne	Tech-grade		Tech-grade	Others
2014	347,000	63,300	241,000	30,100	25,896	241,000	4,204
2015	399,000	82,300	254,000	34,600	30,106	253,000	4,494
2016	479,000	83,800	303,500	47,600	42,887	308,500	4,713
2017	511,000	119,800	307,000	52,900	48,020	304,000	4,880
2018	561,000	129,800	325,000	56,600	55,270	320,312	5,018
2019	561,000	133,800	338,000	56,400	56,153	332,102	5,145
2020	581,000	133,800	340,000	60,200	60,231	334,588	5,381
2021	603,000	133,800	352,500	61,300	61,342	346,894	5,564

Note: 1. The year-end inventory of tech-grade glycine is taken into account, while that of others is not.

2. Others include feed-grade, food-grade and pharmaceutical-grade glycine.

Source: China Customs & CCM

Table 1.1-2 Supply and demand of glycine except tech-grade in China, 2014–2021

Year	Output, tonne			Export, tonne			Apparent consumption, tonne		
	Food-grade	Feed-grade	Pharmaceutical-grade	Food-grade	Feed-grade	Pharmaceutical-grade	Food-grade	Feed-grade	Pharmaceutical-grade
2014	25,550	1,700	2,850	23,533	583	1,780	2,017	1,117	1,070
2015	27,110	5,450	2,040	24,987	4,200	919	2,123	1,250	1,121
2016	38,300	7,240	2,060	36,096	5,946	845	2,204	1,294	1,215
2017	44,470	6,200	2,230	42,193	4,852	975	2,277	1,348	1,255
2018	46,300	8,600	1,700	43,953	7,225	405	2,347	1,375	1,295
2019	46,650	7,750	2,000	44,221	6,345	689	2,429	1,405	1,311
2020 (est.)	49,250	8,800	2,150	46,710	7,362	747	2,540	1,438	1,403
2021 (est.)	49,830	9,280	2,190	47,213	7,753	770	2,617	1,527	1,420

Note: The year-end inventory is not taken into account.

Source: China Customs & CCM

1.2 Classification of glycine

Table 1.2-1 Comparison on properties of Chinese glycine and overseas glycine

Index	Chinese glycine				Overseas glycine	
	Pharmaceutical-grade	Food-grade	Feed-grade	Tech-grade	Food- & pharmaceutical-grade	USP-24, BP-98
Appearance	White crystalline powder				White crystalline powder	
Purity (C ₂ H ₅ NO ₂), %	99.5–101.5	98.5–101.5	98.5–101.5	≤98.5	99.5–101.5	98.5–101.5
Chlorine (Cl ⁻), %	≤0.007	≤0.021	≤0.50	≤0.70	≤0.006	≤0.007
Heavy metal, %	≤0.002	≤0.002	≤0.002	/	≤0.001	≤0.002
Lead (Pb), %	/	/	≤0.0005	/	≤0.0005	/
Sulfate (SO ₄ ⁺), %	≤0.006	≤0.0065	/	/	≤0.006	≤0.0065
Arsenic (As), %	≤0.0002	≤0.0002	≤0.0003	/	≤0.0001	/
Ferric (Fe), %	/	/	/	≤0.003	≤0.001	/
Ammonia (NH ₄ ⁺), %	≤0.01	≤0.02	/	/	≤0.01	/
Loss on drying, %	≤0.2	≤0.2	≤0.2	≤0.3	≤0.07	≤0.2
Ash content, %	≤0.1	≤0.1	≤0.1	/	≤0.05	≤0.1
PH value	5.5–6.5	5.5–6.5	/	/	5.8–6.2	/

Source: CCM

In China, glycine is typically manufactured and sold in four grades: tech-grade (≤ 98.5%), food-grade (98.5%–101.5%), feed-grade (98.5%–101.5%) and pharmaceutical-grade (99.5%–101.5%). Chinese producers mainly produce tech-grade glycine for diverse uses. Quite different from the situation in most overseas countries, the output of and demand for tech-grade glycine account for over 85% and 95% of China's total respectively.

Content of glycine and chlorine is key parameter in glycine quality evaluation.

In international market, glycine is mainly made from hydrocyanic acid, by-product of acrylonitrile production. The glycine produced adopting this method has good properties with high glycine content (about 99%), and low chloride content which is about 1/30 of that of homemade products.

In China, glycine is mainly produced through the chloroacetic acid ammonolysis process with relatively higher production cost and lower glycine content compared with that overseas. Glycine productivity by this process can reach 90% and there is no significant quality disparity among the homemade products.

Glycine with content of 98.5% is the most common specification in China. As for higher glycine content, re-crystallization is needed, resulting in increased production cost. Because of this, domestic glyphosate producers prefer glycine with content of 98.5% (tech-grade) without re-crystallization.

2 Market situation of glycine in China

2.1 Supply of glycine in China

2.1.1 Capacity and output of glycine in China

China's glycine capacity grew rapidly from 347,000 t/a in 2014 to 561,000 t/a in 2018, at a CAGR of 12.8% in this period. But Chinese glycine industry has witnessed overcapacity for quite a while, and this situation will not change much in the coming few years.

In 2017, national capacity of glycine (tech-grade) reached 511,000 t/a during which Hebei Chuncheng finished a 10,000 t/a tech-grade glycine project and Hebei Huaheng completed a 22,000 t/a tech-grade glycine project.

The capacity of tech-grade glycine came to 561,000 t/a in 2018. The 30,000 t/a tech-grade glycine and 10,000 t/a food-grade glycine of Hainan Zhengye Fine Chemical Co., Ltd. was put into production in 2018. Xizang Newtrend Fine Chemical Co., Ltd. built up 40,000 t/a tech-grade glycine production lines. And Hebei Donghua's capacity expanded to 192,000 t/a. The national capacity was maintained at the same level in 2019. However, Yuanshi Xinhongsheng Pharmaceutical Technology Co., Ltd. built a 10,000 t/a glycine project (8,000 t/a tech-grade), while Shijiazhuang Zexing's 10,000 t/a glycine lines (8,000 t/a tech-grade) stopped production.

In 2020, the capacity of tech-grade glycine reached 581,000 t/a, as Linyi Hongtai Chemical Co., Ltd. expanded its glycine capacity by 20,000 t/a.

In 2021, China's total capacity of glycine (tech-grade) reached 603,000 t/a. Cangzhou Huachen Biological Technology Co., Ltd. (a subsidiary of Hebei Huayang Biological Technology Co., Ltd.) completed a 30,000 t/a tech-grade glycine project, and put it into production in November.

Table 2.1.1-1 Capacity and output of glycine in China, 2014–2021

Year	Capacity, t/a		Output, tonne			
	Tech-grade	Others	Tech-grade	Food-grade	Feed-grade	Pharmaceutical-grade
2014	347,000	63,300	241,000	25,550	1,700	2,850
2015	399,000	82,300	254,000	27,110	5,450	2,040
2016	479,000	83,800	303,500	38,300	7,240	2,060
2017	511,000	119,800	307,000	44,470	6,200	2,230
2018	561,000	129,800	325,000	46,300	8,600	1,700
2019	561,000	133,800	338,000	46,650	7,750	2,000
2020	581,000	133,800	340,000	49,250	8,800	2,150
2021	603,000	133,800	352,500	49,830	9,280	2,190

Note: "Others" includes food-grade, feed-grade and pharmaceutical-grade glycine.

Source: CCM

2.1.2 Key glycine producers in China

- Production of various grades of glycine by producer in China

In China, there were 21 active producers of glycine as of June 2022, of which 10 are located in Hebei Province.

Among the 21 active producers, 7 companies engage in tech-grade glycine production only, 7 produce both tech-grade glycine and glycine of other grades, and the rest purchase tech-grade glycine for production of other grades.

Hebei Donghua produces glycine products of all grades. From Jan. 2013 to June 2022, the company was the top glycine producer in China by market share, accounting for about one-third of the national total capacity (tech-grade).

Seven active producers who only produce tech-grade glycine in China are listed as follows. In 2021, the capacity of these seven producers totaled 305,000 t/a, which accounted for 50.6% to the national capacity of tech-grade glycine in China.

- Hubei Trisun Chemical Co., Ltd.
- Linyi Hongtai Chemical Co., Ltd.
- Sichuan Leshan Fuhua Tongda Agro-chemical Technology Co., Ltd.
- Henan HDF Chemical Co., Ltd.
- Inner Mongolia Xingfa Technology Co., Ltd.
- Xizang Newtrend Fine Chemical Co., Ltd.
- Cangzhou Huachen Biological Technology Co., Ltd.

Table 2.1.2-1 Production for various grades of glycine in China by producers, H1 2022

No.	Producer	Abbreviation	Status, H1 2022	Production situation			
				Tech-grade	Food-grade	Feed-grade	Pharmaceutical-grade
1	Hebei Donghua Chemical Group	Hebei Donghua	Active	√	√	√	√
2	Hubei Trisun Chemical Co., Ltd.	Hubei Trisun	Active	√	x	x	x
3	Linyi Hongtai Chemical Co., Ltd.	Linyi Hongtai	Active	√	x	x	x
4	Sichuan Leshan Fuhua Tongda Agro-chemical Technology Co., Ltd.	Fuhua Tongda	Active	√	x	x	x
5	Xizang Newtrend Fine Chemical Co., Ltd.	Xizang Newtrend	Active	√	x	x	x
6	Hainan Zhengye Fine Chemical Co., Ltd.	Hainan Zhengye	Active	√	√	x	x
7	Hebei Huaheng Biological Technology Co., Ltd.	Hebei Huaheng	Active	√	√	√	√
8	Guang'an Chengxin Chemical Co., Ltd.	Guang'an Chengxin	Active	√	√	x	x
9	Henan HDF Chemical Co., Ltd.	Henan HDF	Active	√	x	x	x
10	Inner Mongolia Xingfa Technology Co., Ltd.	Inner Mongolia Xingfa	Active	√	x	x	x
11	Shandong Zhenxing Chemical Industry Co., Ltd.	Shandong Zhenxing	Idle	√	x	x	x

No.	Producer	Abbreviation	Status, H1 2022	Production situation			
				Tech-grade	Food-grade	Feed-grade	Pharmaceutical-grade
12	Hebei Huayang Biological Technology Co., Ltd.	Hebei Huayang	Active	√	√	√	√
13	Cangzhou Huachen Biological Technology Co., Ltd.	Cangzhou Huachen	Active	√	x	x	x
14	Hebei Chuncheng Biological Technology Co., Ltd.	Hebei Chuncheng	Active	√	√	x	x
15	Yuanshi Xinhongsheng Pharmaceutical Technology Co., Ltd.	Yuanshi Xinhongsheng	Active	√	√	√	√
16	Hebei Granray Bioproducts Co., Ltd.	Hebei Granray	Active	x	√	√	√
17	Jiangxi Ansun Food Ingredients Co., Ltd.	Jiangxi Ansun	Active	x	√	x	x
18	Shijiazhuang Shixing Amino Acid Co., Ltd.	Shijiazhuang Shixing	Active	x	√	√	√
19	Nantong Guangrong Chemical Co., Ltd.	Nantong Guangrong	Active	x	√	√	√
20	Suzhou Yotech Fine Chemical Co., Ltd.	Suzhou Yotech	Idle	x	√	√	√
21	Hubei Bafeng Pharmaceuticals & Chemicals Co., Ltd.	Hubei Bafeng	Active	x	x	x	√
22	Hebei Changhao Biotechnology Co., Ltd.	Hebei Changhao	Active	x	√	√	√
23	Shijiazhuang Jirong Pharmaceutical Co., Ltd.	Shijiazhuang Jirong	Active	x	√	√	√
24	Shijiazhuang Zexing Amino Acids Co., Ltd.	Shijiazhuang Zexing	Stopped	x	x	x	x

Note: √: produce, X: not produce

Source: CCM

Table 2.1.2-2 Capacity of glycine by producers in China, 2017–2021, t/a

No.	Producer	2021		2020		2019		2018		2017	
		Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
1	Hebei Donghua	192,000	35,000	192,000	35,000	192,000	35,000	192,000	31,000	182,000	31,000
2	Hubei Trisun	100,000	0	100,000	0	100,000	0	100,000	0	100,000	0
3	Linyi Hongtai	70,000	0	70,000	0	50,000	0	50,000	0	50,000	0
4	Fuhua Tongda	40,000	0	40,000	0	40,000	0	40,000	0	40,000	0
5	Xizang Newtrend	40,000	0	40,000	0	40,000	0	40,000	0	0	0
6	Hainan Zhengye	30,000	10,000	30,000	10,000	30,000	10,000	30,000	10,000	0	0
7	Hebei Huaheng	22,000	30,000	22,000	30,000	22,000	30,000	22,000	30,000	22,000	30,000
8	Guang'an Chengxin	20,000	8,000	20,000	8,000	20,000	8,000	20,000	8,000	20,000	8,000
9	Henan HDF	15,000	0	15,000	0	15,000	0	15,000	0	15,000	0
10	Inner Mongolia Xingfa	10,000	0	10,000	0	10,000	0	10,000	0	10,000	0
11	Shandong Zhenxing	10,000	0	10,000	0	10,000	0	10,000	0	10,000	0
12	Hebei Huayang	6,000	11,000	6,000	11,000	6,000	11,000	6,000	11,000	6,000	11,000
13	Cangzhou Huachen	30,000	0	0	0	0	0	0	0	0	0
14	Hebei Chuncheng	10,000	3,000	10,000	3,000	10,000	3,000	10,000	3,000	10,000	3,000
15	Yuanshi Xinhongsheng	8,000	2,000	8,000	2,000	8,000	2,000	0	0	0	0
16	Hebei Granray	0	5,000	0	5,000	0	5,000	0	5,000	0	5,000
17	Jiangxi Ansun	0	20,000	0	20,000	0	20,000	0	20,000	0	20,000
18	Shijiazhuang Shixing	0	2,500	0	2,500	0	2,500	0	2,500	0	2,500
19	Nantong Guangrong	0	3,000	0	3,000	0	3,000	0	3,000	0	3,000
20	Suzhou Yotech	0	1,000	0	1,000	0	1,000	0	1,000	0	1,000
21	Hubei Bafeng	0	700	0	700	0	700	0	700	0	700
22	Hebei Changhao	0	2,000	0	2,000	0	2,000	0	2,000	0	2,000
23	Shijiazhuang Jirong	0	400	0	400	0	400	0	400	0	400
24	Shijiazhuang Zexing	0	0	0	0	0	0	8,000	2,000	8,000	2,000
Others		0	200	8,000	200	8,000	200	8,000	200	38,000	200
Total		603,000	133,800	581,000	133,800	561,000	133,800	561,000	129,800	511,000	119,800

Note: "Others" includes food-grade, feed-grade and pharmaceutical-grade glycine.

Source: CCM

- Distribution and market share of glycine producers in China

Generally speaking, Chinese glycine producers are mainly located in places where raw materials such as chlor-alkali, chloroacetic acid and natural gas are adequate, mainly resulted from governmental restriction on transportation of highly toxic chemicals including chlor-alkali, chloroacetic acid and HCN.

In particular, most glycine production in China is concentrated in chlor-alkali-rich Hebei Province, where capacity of tech-grade glycine was 268,000 t/a in 2021, taking up to 36.4% of the national capacity (all grades). Guang'an Chengxin, the only producer producing glycine via the Hydantion process, is located in Sichuan Province.

Figure 2.1.2-1 Distribution of major glycine producers by capacity of tech-grade glycine in China, 2021



Source: CCM

Figure 2.1.2-2 Distribution of major glycine producers by company number of tech-grade glycine in China, 2021



Source: CCM

Table 2.1.2-3 Industrial concentration of tech-grade glycine in terms of output in China, 2017–2021

No.	Item	Value				
		2021	2020	2019	2018	2017
1	Top one concentration ratio	36.9%	38.2%	38.5%	43.1 %	42.3%
2	Top three concentration ratio	71.8%	72.1%	71.6%	74.8%	79.2%
3	Top five concentration ratio	84.0%	84.4%	84.0%	86.2%	90.6%
4	HHI	2,160	2,236	2,280	2,546	2,710

Source: CCM

China's glycine industry is highly concentrated. The high concentration mainly embodies in large-scale production, which is beneficial for top players to reduce cost and control market price.

Actually, pioneering the glycine industry, Hebei Donghua has always played a predominant role in pricing. The company always takes the lead in setting price which is usually followed by other domestic producers. Indeed, evidences from CCM's studies suggest that domestic glycine producers have gained more profits by making the most use of high production concentration and taking advantage of pricing power.

However, the concentration has kept declining in the past few years, and the HHI will decline in the coming few years because some producers are possible to equip themselves with new facilities that can produce more than ten-thousand tonnes of glycine each year. These companies include Inner Mongolia Xingfa, Shaanxi Beiyuan and Henan HDF.

In the next five years, Hebei Donghua will still remain competitive but its competitiveness will decline.

Some glyphosate producers have established or will establish glycine facilities for their glyphosate production.

- Glyphosate producers Hubei Trisun and Inner Mongolia Xingfa have established glycine plants, with the glycine capacity of 100,000 t/a and 10,000 t/a respectively, and the latter also has a 60,000 t/a expansion plan.
- Glyphosate producer Henan HDF has established 15,000 t/a glycine installation, and it proposes a 40,000 t/a (1st phase 20,000 t/a, 2nd phase 20,000 t/a) expansion plan.
- Glyphosate producer Guang'an Chengxin has established 28,000 t/a glycine installation, and plans to increase the capacity by 30,000 t/a (10,000 t/a food-grade glycine and 20,000 t/a tech-grade glycine).

- Output of glycine by producer in China

Table 2.1.2-4 Output of glycine in China by producer, 2017–2021, tonne

No.	Producer	2021		2020		2019		2018		2017	
		Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
1	Hebei Donghua	130,000	20,000	130,000	20,000	130,000	20,000	140,000	20,000	130,000	20,000
2	Hubei Trisun	88,000	0	80,000	0	84,000	0	73,000	0	83,000	0
3	Linyi Hongtai	35,000	0	35,000	0	28,000	0	30,000	0	30,000	0
4	Fuhua Tongda	26,000	0	25,000	0	25,000	0	22,000	0	20,000	0
5	Xizang Newtrend	6,000	0	6,000	0	6,000	0	6,000	0	0	0
6	Hainan Zhengye	10,000	800	10,000	800	8,000	300	2,000	0	0	0
7	Hebei Huaheng	5,000	7,500	5,000	7,300	5,000	6,200	4,000	6,600	3,000	8,800
8	Guang'an Chengxin	17,000	2,500	17,000	2,500	17,000	2,500	15,000	2,500	15,000	1,400
9	Henan HDF	11,000	0	10,000	0	11,000	0	12,000	0	10,000	0
10	Inner Mongolia Xingfa	10,000	0	10,000	0	10,000	0	10,000	0	10,000	0
11	Shandong Zhenxing	500	0	1,000	0	1,000	0	1,000	0	2,000	0
12	Hebei Huayang	3,000	10,000	3,000	11,000	5,000	10,000	5,000	11,000	4,000	11,000
13	Cangzhou Huachen	3,000	0	0	0	0	0	0	0	0	0
14	Hebei Chuncheng	3,500	2,000	5,000	1,500	5,000	1,000	5,000	1,000	0	1,000
15	Yuanshi Xinhongsheng	4,500	1,000	3,000	1,000	3,000	1,000	0	0	0	0
16	Hebei Granray	0	2,500	0	2,500	0	2,600	0	2,300	0	1,800
17	Jiangxi Ansun	0	12,000	0	10,000	0	9,200	0	9,400	0	5,000
18	Shijiazhuang Shixing	0	1,000	0	1,200	0	1,200	0	1,100	0	1,100
19	Nantong Guangrong	0	1,000	0	1,000	0	1,000	0	1,000	0	1,100
20	Suzhou Yotech	0	0	0	200	0	200	0	200	0	200
21	Hubei Bafeng	0	100	0	100	0	100	0	100	0	100
22	Hebei Changhao	0	800	0	1,000	0	1,000	0	1,000	0	1,000
23	Shijiazhuang Jirong	0	100	0	100	0	100	0	100	0	100
24	Shijiazhuang Zexing	0	0	0	0	0	0	0	300	0	300
Others		0	0	0	0	0	0	0	0	0	0
Total		352,500	61,300	340,000	60,200	338,000	56,400	325,000	56,600	307,000	52,900

Note: "Others" includes food-grade, feed-grade and pharmaceutical-grade glycine.

Source: CCM

- Capacity utilization of glycine by producer in China

Table 2.1.2-5 Capacity utilization of glycine producer in China, 2017–2021

No.	Producer	2021		2020		2019		2018		2017	
		Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
1	Hebei Donghua	67.7%	57.1%	67.7%	57.1%	67.7%	57.1%	72.9%	64.5%	71.4%	64.5%
2	Hubei Trisun	88.0%	/	80.0%	/	84.0%	/	73.0%	/	83.0%	/
3	Linyi Hongtai	50.0%	/	50.0%	/	56.0%	/	60.0%	/	60.0%	/
4	Fuhua Tongda	65.0%	/	62.5%	/	62.5%	/	55.0%	/	50.0%	/
5	Xizang Newtrend	15.0%	/	15.0%	/	15.0%	/	15.0%	/	/	/
6	Hainan Zhengye	33.3%	8.0%	33.3%	8.0%	26.7%	3.0%	6.7%	0.0%	/	/
7	Hebei Huaheng	22.7%	25.0%	22.7%	24.3%	22.7%	20.7%	18.2%	22.0%	13.6%	29.3%
8	Guang'an Chengxin	85.0%	31.3%	85.0%	31.3%	85.0%	31.3%	75.0%	31.3%	75.0%	17.5%
9	Henan HDF	73.3%	/	66.7%	/	73.3%	/	80.0%	/	66.7%	/
10	Inner Mongolia Xingfa	100.0%	/	100.0%	/	100.0%	/	100.0%	/	100.0%	/
11	Shandong Zhenxing	5.0%	/	10.0%	/	10.0%	/	10.0%	/	20.0%	/
12	Hebei Huayang	50.0%	90.9%	50.0%	100.0%	83.3%	90.9%	83.3%	100.0%	66.7%	100.0%
13	Cangzhou Huachen	10.0%	/	/	/	/	/	/	/	/	/
14	Hebei Chuncheng	35.0%	66.7%	50.0%	50.0%	50.0%	33.3%	50.0%	33.3%	0.0%	33.3%
15	Yuanshi Xinhongsheng	56.3%	50.0%	37.5%	50.0%	37.5%	50.0%	/	/	/	/
16	Hebei Granray	/	50.0%	/	50.0%	/	52.0%	/	46.0%	/	36.0%
17	Jiangxi Ansun	/	60.0%	/	50.0%	/	46.0%	/	47.0%	/	25.0%
18	Shijiazhuang Shixing	/	40.0%	/	48.0%	/	48.0%	/	44.0%	/	44.0%
19	Nantong Guangrong	/	33.3%	/	33.3%	/	33.3%	/	33.3%	/	36.7%
20	Suzhou Yotech	/	0.0%	/	20.0%	/	20.0%	/	20.0%	/	20.0%
21	Hubei Bafeng	/	14.3%	/	14.3%	/	14.3%	/	14.3%	/	14.3%
22	Hebei Changhao	/	40.0%	/	50.0%	/	50.0%	/	50.0%	/	50.0%
23	Shijiazhuang Jirong	/	25.0%	/	25.0%	/	25.0%	/	25.0%	/	25.0%
24	Shijiazhuang Zexing	/	/	/	/	/	/	0.0%	15.0%	0.0%	15.0%
Others		/	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Note: "Others" includes food-grade, feed-grade and pharmaceutical-grade glycine.

Source: CCM

2.1.3 Potential production lines of glycine in China

If potential production capacity goes into production, the capacity of tech-grade glycine in China will increase steadily in the coming five years, from 603,000 t/a in 2021 to over 760,000 t/a in 2026.

Table 2.1.3-1 Potential projects of glycine in China, as of June 2022

Classification	Company	Designed capacity, t/a	Planned commissioning date	Details
Expansion	Hebei Donghua Chemical Group	30,000 tech-grade*	N/A	2nd phase of Hebei Donghua Jiheng Chemical Co., Ltd.'s 60,000 t/a glycine project (1st phase had been put into commercial production in 2018).
	Xizang Newtrend Fine Chemical Co., Ltd.	2nd phase: 90,000 glycine*	N/A	2nd phase 90,000 t/a glycine will be determined by the future market situation. (1st phase including 40,000 t/a tech-grade glycine and 6,000 t/a chloroacetic acid was built up in 2018.)
	Hebei Chuncheng Biological Technology Co., Ltd.	2nd phase: 14,000 tech-grade, 3,000 food-grade*	N/A	2nd phase: 17,000 t/a glycine and 45,000 t/a chloroacetic acid
	Henan HDF Chemical Co., Ltd.	1st phase: 20,000 tech-grade	N/A	1st phase: 20,000 t/a tech-grade glycine 2nd phase: 20,000 t/a tech-grade glycine
	Guang'an Chengxin Chemical Co., Ltd.	20,000 tech-grade, 10,000 food-grade	N/A	20,000 t/a tech-grade glycine, 10,000 t/a food-grade glycine and 2,600 t/a iminodiacetic acid (by-product), etc.
	Inner Mongolia Xingfa Technology Co., Ltd.	60,000 tech-grade	2023	60,000 t/a tech-grade glycine and 90,000 t/a chloroacetic acid
New	Inner Mongolia Jiaquan Chemical Technology Co., Ltd.	20,000 tech-grade*	2023	1st phase (100,000 t/a formaldehyde, 15,000 t/a paraformaldehyde and 6,000 t/a urotropine) was built up in 2015. 2nd phase (100,000 t/a formaldehyde, 15,000 t/a paraformaldehyde, 20,000 t/a glycine, etc.)
	Shaanxi Beiyuan Chemical Industry Group Co., Ltd.	120,000 tech-grade	N/A	120,000 t/a glycine, 180,000 t/a chloroacetic acid
	Kaifeng Longxing Chemical Co., Ltd.	20,000 tech-grade	2022	1st phase: 10,000 t/a tech-grade glycine 2nd phase: 10,000 t/a tech-grade glycine
	Hubei Minteng New Material Technology Co., Ltd.	80,000 tech-grade	N/A	80,000 t/a tech-grade glycine, 240,000 t/a chloroacetic acid and 120,000 t/a epichlorohydrin
	Cangzhou Xulong Chemical Co., Ltd.	2nd phase: 60,000 glycine	N/A	1st phase: 600,000 t/a sulfuric acid 2nd phase: 600,000 t/a sulfuric acid, 60,000 t/a glycine, 60,000 t/a liquid sodium methoxide, etc.
	Inner Mongolia Zhongyuan Pharmaceutical Co., Ltd.	2nd phase: 10,000 glycine	2023	1st phase: 15,000 t/a chloroacetic acid and 10,000 t/a methyl chloroacetate 2nd phase: 10,000 t/a chloroacetic acid and 10,000 t/a glycine

Note: Projects with * have not seen progress for a long time and may have been shelved.

Source: CCM

2.2 Price of glycine in China

2.2.1 Price of glycine in China, Jan. 2014–June 2022

Only the price of tech-grade glycine in China is analysed here, as other three grades glycine are made from tech-grade one, and their prices are mainly subject to that of tech-grade one.

Ex-works price of tech-grade glycine climbed from USD2,097/t in Jan. 2014 to USD2,624/t in April 2014, mainly because glycine producers in Hebei and Shandong provinces, the main production areas, halted or cut production due to the pressure from environmental policies after the Spring Festival.

However, the price soon experienced a declining trend, falling from that temporary peak to USD1,264/t in Nov. 2016, due to the following reasons:

- Demand for glycine from the downstream glyphosate industry declined, and the export volume of glyphosate declined in 2015 compared with that in 2014.
- With new capacity launched, total capacity of glycine increased further and the supply gradually exceeded demand.

From Nov. 2016 to the end of 2017, ex-works price of tech-grade glycine was on an upward trend in general. The price bottomed at USD1,154/t in April 2017 but quickly rose to USD2,621/t in Nov. 2017 and USD2,573/t in Dec. 2017, due to the following reasons:

- The second-, third- and fourth-round environmental inspections were carried out in Nov. 2016, April 2017 and Aug. 2017, respectively. Besides, the supervision of production safety in 2017 had been strengthened. During the environmental inspections, production of glycine was restricted and operating rate of the industry was reduced, which led to short supply of the product.
- After July 2016, China banned the sales and use of paraquat AS, part of whose market was replaced by glyphosate. So the demand for glyphosate had increased, leading to an increase in the demand for glycine.
- Since H2 2016, with the rapid development of overseas glyphosate-resistant genetically modified crops, China's export of glyphosate increased, thus the demand for glycine increased.

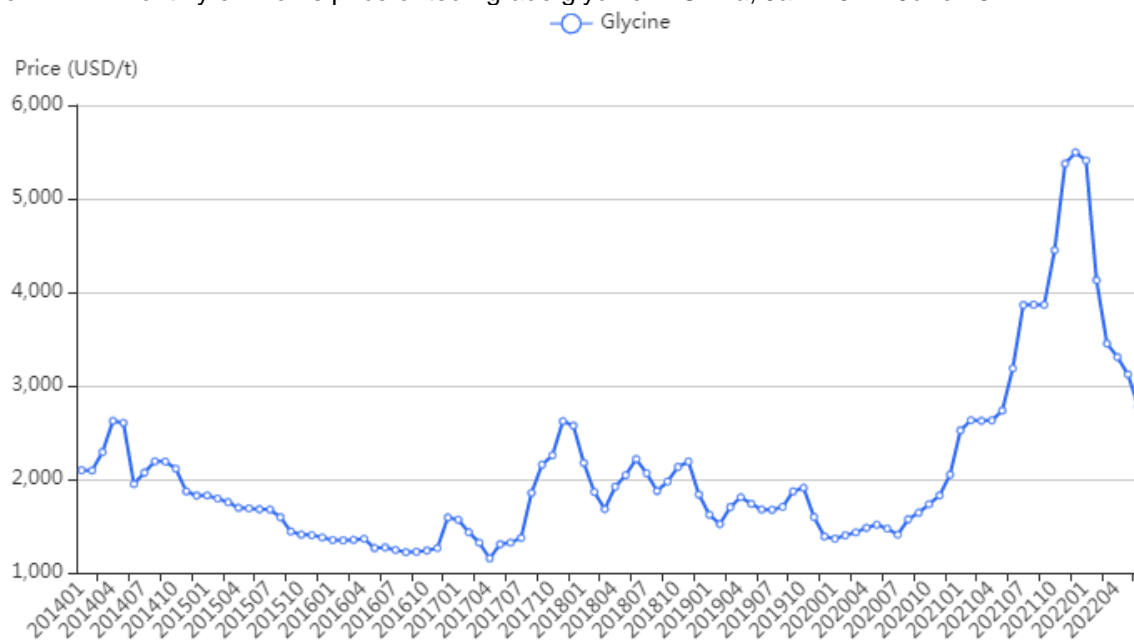
In 2018, the price fluctuated between USD1,600/t–USD2,200/t, and the annual average was about USD2,000/t, driven by the increasing price of glyphosate technical, rising demand for glycine, and stricter environmental protection requirement.

Affected by COVID-19, domestic and foreign demand for glycine decreased in H1 2020, and thus its price kept at a low level. Entering the peak season for glyphosate in H2 2020, demand for glyphosate exceeded its supply, which drove up the demand for glycine. The price of glycine rebounded to USD2,048/t in Dec. 2020.

The price of glycine climbed quickly in Jan., June and July 2021, mainly inspired by the soaring price of glyphosate; the July price reached USD3,863/t. It jumped further up in Q4 2021, mainly due to limited glycine production under COVID-19 situation and domestic power rationing policy, as well as mounting glyphosate export demand brought about by hurricane disasters-led reduced supply overseas. In addition, increases in the prices of raw materials such as urotropine and chloroacetic acid also pushed the price of glycine higher. At the end of 2021, the price of glycine hit a ten-year record at USD5,495/t.

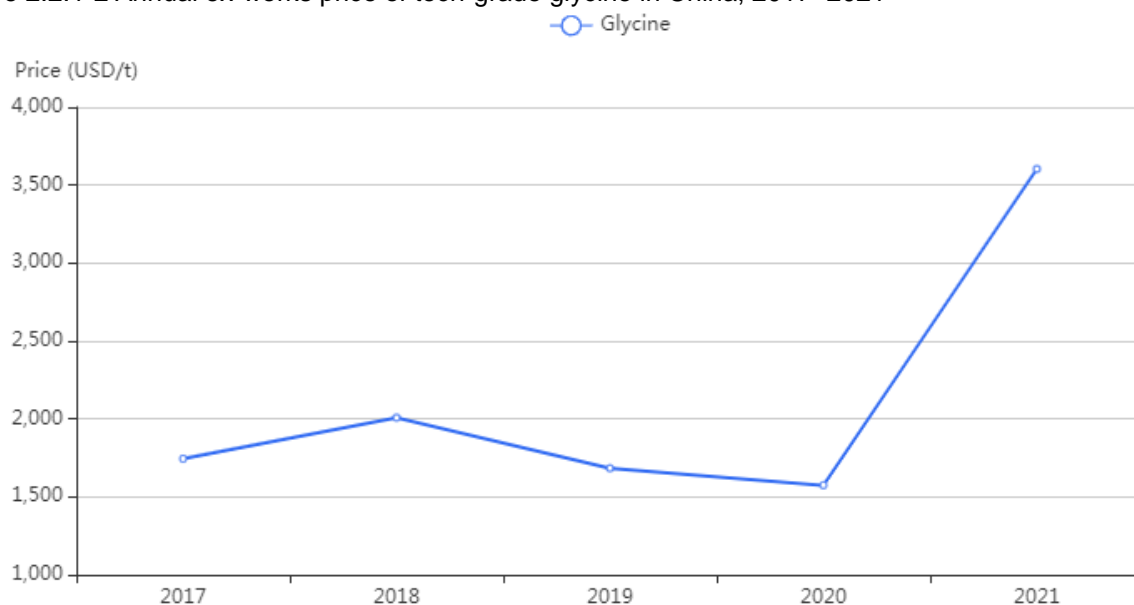
However, the price fell rapidly in H1 2022, going down to USD2,776/t by June. As domestic manufacturers gradually resumed production since early this year, glycine supply recovered. On the demand side, since operation in glyphosate plants abroad also saw gradual recovery, global supply of the product became more stable, leading to a decline in demand for glyphosate export from China. As a result, the demand for glycine diminished.

Figure 2.2.1-1 Monthly ex-works price of tech-grade glycine in China, Jan. 2014–June 2022



Source: CCM

Figure 2.2.1-2 Annual ex-works price of tech-grade glycine in China, 2017–2021



Source: CCM

2.2.2 Factors influencing glycine price in China

Glycine price in China is influenced by the price of glyphosate technical, instant supply of & demand for glycine, government policies, and the price of glycine's raw materials including chloroacetic acid, urotropine, liquid ammonia and methanol.

- Glyphosate technical price

Glycine price in China is largely subject to the price of glyphosate technical, since some 80% of tech-grade glycine is applied in the domestic glyphosate industry.

- Government policies

Under the guidance of national industrial policies, China's amino acid industry has been developing rapidly. And due to some environmental policies, supply of and demand for glycine and enterprises' operating profits in China are limited, affecting the price of glycine.

For example, during the period from Aug. to Oct. 2017, the fourth-round environmental inspection and the national production safety inspection were carried out, glycine production was under stricter supervision, leading to a tight supply of glycine.

And in Sept.–Oct. 2021, under the dual control policy on energy consumption and energy intensity, various provinces and cities rolled out power rationing measures, which led to large-scale suspension of glycine production, resulting in tight glycine supply and soaring price.

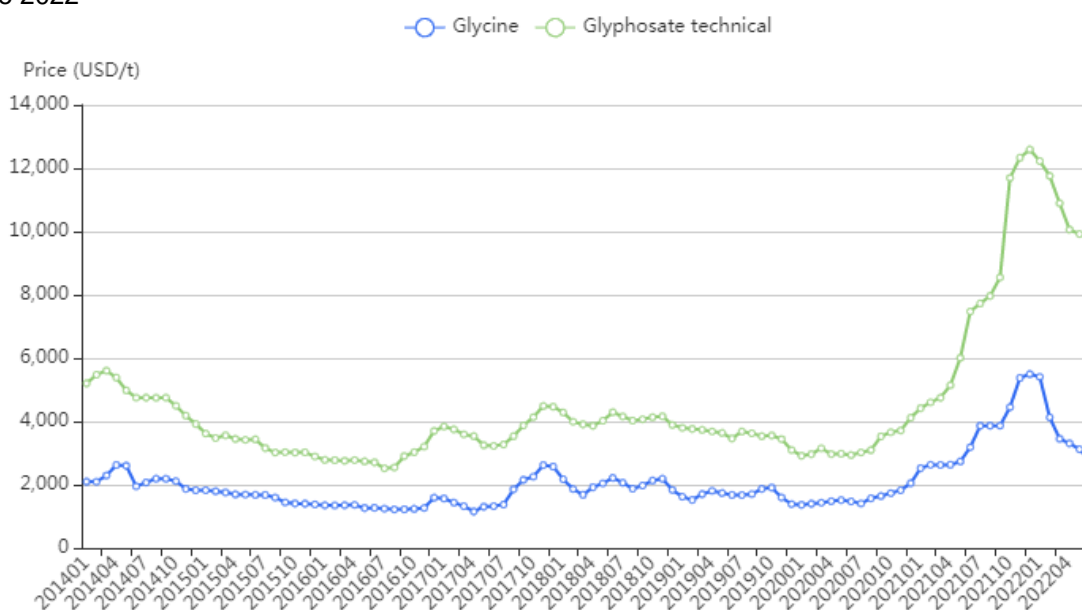
- Instant supply of & demand for glycine

In general, there has been a great oversupply in glycine industry in China, and in most cases, glycine price won't change much. However, the price may increase a lot when the instant supply cannot meet the demand.

- Raw material price

The cost of raw materials, like urotropine and chloroacetic acid, accounts for over 80% of the total production cost of glycine.

Figure 2.2.2-1 Monthly ex-works prices of tech-grade glycine and glyphosate technical in China, Jan. 2014–June 2022



Source: CCM

2.2.3 Price trend of glycine in China

Glycine mainly follows the trend of glyphosate's market price. As of June 2022, the price of glyphosate had gone down by about 20% from Jan. 2022, and the price of glycine dropped by nearly 49%. Market supply of glycine returned to normal, and the price continued to fall and backed to previous level, due to reduced downstream demand as glyphosate was in stable supply in the market.

Glyphosate market will usher in peak season in Q4, and usually domestic glycine producers have larger inventory during this time, so glycine price is expected to decrease slightly. But at the same time, with tightening of China's environmental policy in winter time, the price of glycine will be affected by policy factors.

It is estimated that the annual ex-works price of tech-grade glycine in China will range between USD2,200/t–USD3,000/t during H2 2022–2024.

2.3 Production technology of glycine

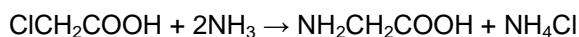
There are three major glycine production methods in the world, namely the chloroacetic acid ammonolysis process, the Strecker process and the Hydantion process.

In China, glycine is mainly produced via the chloroacetic acid ammonolysis process, which is a mature production technology adopted by almost all domestic glycine producers except Guang'an Chengxin.

Guang'an Chengxin is the only company in China adopting the Hydantion process to produce glycine. This production process has advantages such as less reaction steps, higher yield, higher purity, lower production cost and less pollution, compared with the chloroacetic acid ammonolysis process.

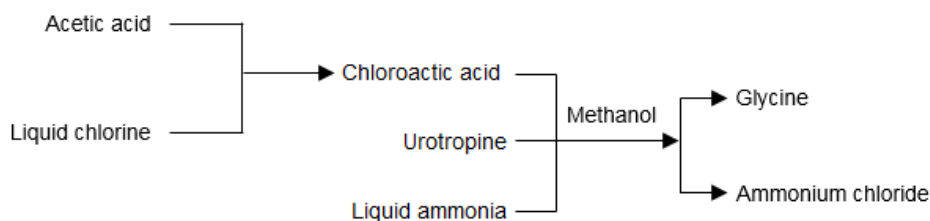
2.3.1 Brief introduction of the chloroacetic acid ammonolysis process

The reaction equation of chloroacetic acid ammonolysis process is as follows:



Main materials for glycine production by chloroacetic acid ammonolysis process include chloroacetic acid, ammonia and urotropine. Chloroacetic acid and ammonia are mixed in urotropine solution. When the reaction is finished, methanol is added to the solution for separation of glycine from the byproduct, ammonium chloride.

Figure 2.3.1-1 Flowchart of chloroacetic acid ammonolysis process for glycine production



Source: CCM

As a major glycine production method in China, chloroacetic acid ammonolysis process has some advantages:

- Simple and mature process
- Low requirements for equipment performance
- Easy availability of raw materials

However, the disadvantages of this method are also obvious:

High production cost

Besides huge consumption of raw materials, there is also quite high energy consumption for removal and disposal of a large quantity of ammonium chloride in wastewater in the chloroacetic acid ammonolysis process. Meanwhile, the catalyst—urotropine, cannot be reclaimed, which largely increases production cost as well.

Poor product quality

Only tech-grade glycine can be produced through chloroacetic acid ammonolysis process. In order to get higher grade glycine, tech-grade glycine needs to be decolorized and recrystallized.

Serious environment pollution

Three tonnes of wastewater can be generated from one tonne glycine production through chloroacetic acid ammonolysis process and wastewater discharged contains large amount of ammonium chloride, formaldehyde and ammonia nitrogen.

Regional concentration

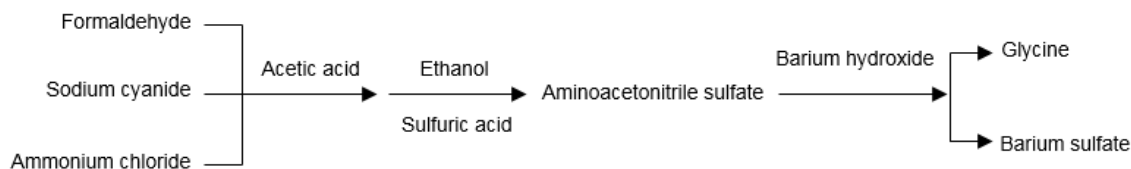
Companies adopting this process have to set up their factories close to raw material producers. As liquid

chlorine and liquid ammonia, the raw materials of chloroacetic acid, are hazardous chemicals and difficult to transport. So a big number of chloroacetic acid and glycine producers in China are located in Hebei Province, which is one of China's major production areas of liquid chlorine and liquid ammonia.

2.3.2 Brief introduction of the Strecker process

Strecker process is a popular glycine production method in foreign countries.

Figure 2.3.2-1 Flowchart of the Strecker process for glycine production



Source: CCM

Strecker process is quite suitable for large-scale glycine production, mainly attributed to the ease of purification of the product. However, sodium cyanide, a major raw material in the Strecker process, is poisonous, so the process has disadvantages, such as harsh operating conditions, complex process, long synthetic process route.

Some foreign research institutions have improved Strecker process—replacing sodium cyanide with hydrocyanic acid, which shortens the synthesis process, lowers production cost, and achieves higher product yield.

2.3.3 Brief introduction of the Hydantion process

Glycine production by the Hydantion process uses glycolonitrile, carbon dioxide and ammonia as raw materials. Glycolonitrile can be formed after formaldehyde reacts with hydrogen cyanide with excess amounts of sodium cyanide as the catalyst.

Firstly, glycolonitrile reacts with carbon dioxide and ammonia at about 100 °C to form a more stable compound. Subsequently, the main reaction proceeds at about 150 °C. After the reactions are steady, the reaction solution is concentrated to remove water, ammonia and carbon dioxide, thereby undergoing crystallization to obtain glycine. The water, ammonia and carbon dioxide removed could be recycled and the mother liquor is also fed to the reaction zone. The glycine yield could be significantly improved by recycling the mother liquor.

Using the mixture of compounds, namely ammonia and carbon dioxide under the reaction conditions, with the presence of ammonium carbonate and ammonium bicarbonate, is possible to achieve favorable results.

The reaction equation of the Hydantion process is as follows:

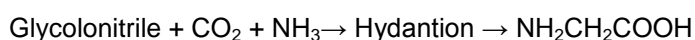
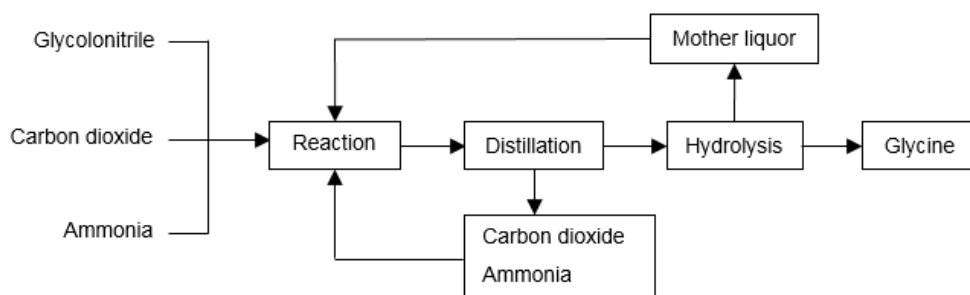


Figure 2.3.3-1 Flowchart of the Hydantion process for glycine production



Source: CCM

Using glycolonitrile as a raw material to produce glycine, the Hydantion process not only solves the shortcoming that hydrocyanic acid is difficult to handle, but also maintains the advantages improved Strecker process has.

The Hydantion process adopted by Guang'an Chengxin uses glycolonitrile, ammonia, sodium hydroxide and sulfuric acid as raw materials, with iminodiacetic acid and sodium sulfate anhydrous as by-products.

2.3.4 Development trend of glycine technology

The chloroacetic acid ammonolysis process will still be popular, and the Hydantion process will play as a supplement in the next few years, unless important glycine production technical innovation appears.

As for the chloroacetic acid ammonolysis process, though glycine made by this process has a purity of only 95% with high chloride and formaldehyde content, the process is mature and the key raw materials are abundant and also easily produced (simple technology).

The Hydantion process has advantages of less reaction steps, high purity (98.5%), lower production cost and less pollution. However, it is difficult to secure steady supply of natural gas, which acts as the initial raw material for glycine production, since consumption need for this product has expanded quickly these years. In addition, the Hydantion process has high requirements on production equipment.

2.4 Raw materials for glycine production in China, 2021

Urotropine and chloroacetic acid, two main raw materials for glycine production via the chloroacetic acid ammonolysis process, both have weak market positions compared with the downstream sectors of glycine, thereby having slight impacts on domestic glycine industry.

2.4.1 Urotropine

Urotropine is prepared from the reaction of formaldehyde and liquid ammonia. It is a kind of raw material for curing agent of phenolic plastics, catalytic agent of amino plastics, blowing agent H (DPT) of vulcanized rubbers, black explosives and pesticides.

The national capacity of urotropine was about 456,000 t/a in 2021. For the top 15 producers, their total capacity accounted for 86.8% to the national total. About half of urotropine producers in China are located in Xinjiang and Hebei provinces, both of which are important production bases for formaldehyde and liquid ammonia—urotropine's raw materials.

Table 2.4.1-1 Main urotropine producers in China, 2021

No.	Company	Location	Capacity, t/a
1	Hutubi Ruiyuantong Chemical Co., Ltd.	Xinjiang	50,000
2	Xinjiang Wanchang New Energy Co., Ltd.	Xinjiang	50,000
3	Shandong Runyin Bio-chemicals Co., Ltd.	Shandong	30,000
4	Tianshan Green Kuqa Petrochemical Co., Ltd.	Xinjiang	30,000
5	Jiaozuo Runhua Chemical Industry Co., Ltd.	Henan	30,000
6	Inner Mongolia Jiaquan Chemical Technology Co., Ltd.	Inner Mongolia	30,000
7	Shanxi Fengxi Fertilizer Industry (Group) Co., Ltd.	Shanxi	30,000
8	Hebei Yuhang Chemical Industry Co., Ltd.	Hebei	20,000
9	Jiangsu Sanmu Group Co., Ltd.	Jiangsu	20,000
10	Shanxi Lanhua Sci-tech Venture Co., Ltd.	Shanxi	20,000
11	Xinjiang Huachun Energy Co., Ltd.	Xinjiang	20,000
12	Gansu Taier Fine Chemical Co., Ltd.	Gansu	20,000
13	Hubei Trisun Chemical Co., Ltd.	Hubei	18,000
14	Bazhou Zhengyuan Chemicals Co., Ltd.	Xinjiang	15,000
15	Sichuan Leshan Fuhua Tongda Agro-chemical Technology Co., Ltd.	Sichuan	13,000
Sub-total			396,000
National total			456,000
Share of top 15			86.8%

Source: CCM

The top five urotropine producers (by capacity) took up 41.7% of the national capacity of urotropine in 2021. The Herfindahl-Hirschman Index (HHI) of urotropine in China was 613, which is far lower than 1,800, suggesting that urotropine market in China is not concentrated and it would be easy for this industry to realize capacity concentration if any merger and acquisition is proposed. According to the US Department of Justice's merger guidelines, an industry is considered as "concentrated" if the HHI exceeds 1,800.

Table 2.4.1-2 Industrial concentration of urotropine in terms of capacity in China, 2021

No.	Item	Value
1	Top five concentration ratio	41.7%
2	Top ten concentration ratio	68.0%
3	Herfindahl-Hirschman Index (HHI)	613

Source: CCM

In China, urotropine is mainly consumed in phenolic plastics, explosives and glycine. About 40% of urotropine is used as curing agent of phenolic plastics; 20% is consumed in the production of cyclotrimethylene trinitramine (RDX) and about 15% is used in glycine.

To sum up, China's urotropine industry has entered a mature stage. Though a certain amount of urotropine still needs to be imported to satisfy domestic demand each year, urotropine will not impose great influence on glycine industry.

2.4.2 Chloroacetic acid

Chloroacetic acid, a kind of chemical intermediate, is mainly used for the production of carboxymethyl cellulose (CMC), agrochemicals and surfactants overseas. However, in China, the application situation is different, with pesticides being the largest end-use segment, followed by pharmaceuticals, dyeing, CMC, carboxymethyl starch, etc.

There were about 18 chloroacetic acid producers in China with total capacity of about 1,235,000 t/a in 2021. Shandong, Henan and Hebei provinces are the main production areas.

Large glycine producers, such as Hebei Donghua, Hubei Trisun, Linyi Hongtai, Fuhua Tongda, self-developed chloroacetic acid production installations to acquire chloroacetic acid, to reduce production cost of glycine.

Table 2.4.2-1 Main chloroacetic acid producers in China, 2021

No.	Company	Location	Capacity, t/a
1	Hebei Donghua Chemical Group	Hebei	250,000
2	Hubei Trisun Chemical Co., Ltd.	Hubei	160,000
3	Shandong Minji Chemical Co., Ltd.	Shandong	120,000
4	Nouryon Chloroacetic Acid Chemical (Taixing) Co., Ltd.	Jiangsu	120,000
5	Linyi Hongtai Chemical Co., Ltd.	Shandong	100,000
6	Henan Lianchuang Chemical Co., Ltd.	Henan	60,000
7	China Pingmei Shenma Group Kaifeng Dongda Chemical Co., Ltd.	Henan	60,000
8	Sichuan Leshan Fuhua Tongda Agro-chemical Technology Co., Ltd.	Sichuan	55,000
9	Hebei Bawei Chemical Co., Ltd.	Hebei	50,000
10	Dongying Huatai Fine Chemical Co., Ltd.	Shandong	50,000
11	Shanxi Yushe Chemical Co., Ltd.	Shanxi	50,000
12	CABB Jinwei Specialty Chemicals (Jining) Co., Ltd	Shandong	45,000
13	Weifang Binhai Petrochemical Co., Ltd.	Shandong	40,000
14	Jiyuan Fangshen Chemistry Co., Ltd	Henan	20,000
15	Henan HDF Chemical Co., Ltd.	Henan	15,000
Sub-total			1,195,000
National total			1,235,000
Share of top 15			96.8%

Source: CCM

The top five chloroacetic acid producers (by capacity) accounted for about 60.7% of the domestic market share in 2021, meaning that chloroacetic acid is predominated by these top players. The Herfindahl-

Hirschman Index (HHI) was 980 in 2021, suggesting that the market is not concentrated.

Table 2.4.2-2 Industrial concentration of chloroacetic acid in terms of capacity in China, 2021

No.	Item	Value
1	Top five concentration ratio	60.7%
2	Top ten concentration ratio	83.0%
3	Herfindahl-Hirschman Index (HHI)	980

Source: CCM

Chloroacetic acid in China has faced overcapacity for many years, and domestic capacity will be stable in the coming few years, under the situation of stricter environmental protection requirement.

2.5 Export of glycine in China, 2013–2019

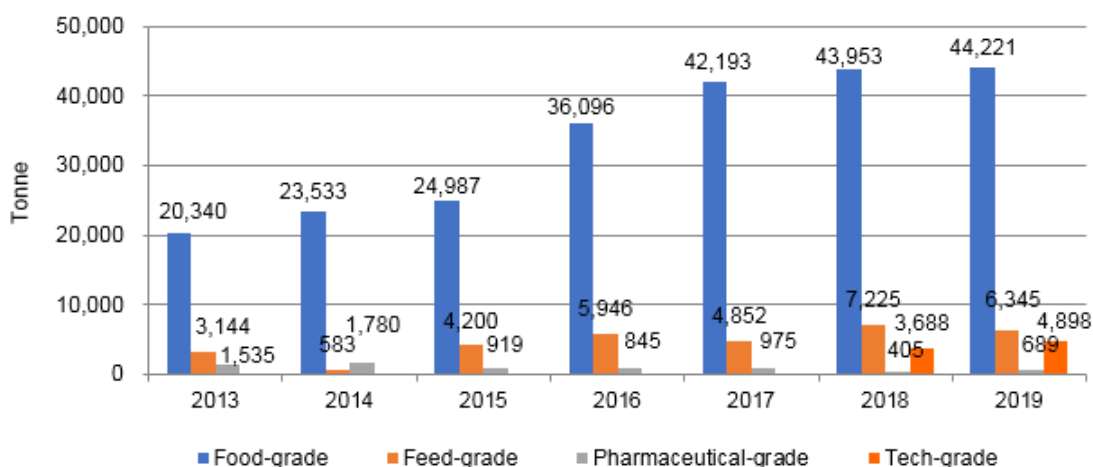
- Export volume of glycine in China

China's total export volume of glycine increased on the whole in 2013–2019, rising from 25,019 tonnes in 2013 to 56,153 tonnes in 2019.

China started to export tech-grade glycine in 2018, with the export volume of 3,688 tonnes, accounting for 6.7% of total export volume of glycine in 2018. In 2019, the export volume of tech-grade glycine increased greatly to 4,898 tonnes which took up to 8.7% of the whole.

Food-grade glycine is the main glycine product exported in China, with its volume accounting for 87.9%, 79.5% and 78.8% of the total glycine export volume during 2017–2019 respectively. And it increased from 20,340 tonnes to 44,221 tonnes with a CAGR of 13.8% from 2013 to 2019.

Figure 2.5-1 China's export volume of various grades glycine, 2013–2019



Source: China Customs & CCM

- Export price of glycine in China

The average export price of food-grade glycine in China hovered ranging from USD2,000/t to USD2,100/t in 2013, and experienced a fast rise in 2014 to a record high around USD2,400/t–USD2,700/t from April to Nov. because of tech-grade glycine's high price.

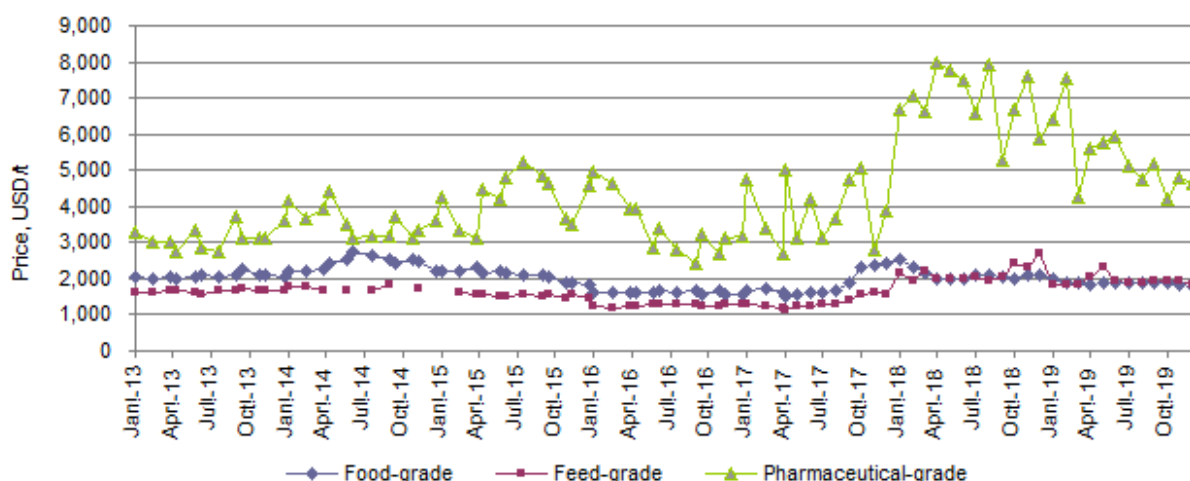
Since the end of 2014, the export price of food-grade glycine was on the decline continuously, reaching only about USD1,552/t in Dec. 2016. Since Jan. 2017, export price of food-grade glycine rebounded and climbed to USD2,518/t in Jan. 2018, due to the gradual rises in the prices of domestic glyphosate technical and tech-grade glycine. The export price of food-grade glycine kept declining since Feb. 2018 and in 2019, the price was pretty stable, though still on decline, ranging from USD1,800/t to USD2,000/t. The decrease was mainly influenced by the increasing export volume and sufficient supply.

During 2013–2019, the average export price of feed-grade glycine showed the same trend as that of food-grade glycine. In 2019, the export price of feed-grade glycine was stable and close to the price of food-grade glycine.

The average export price of pharmaceutical-grade glycine fluctuated greatly compared with food- and feed-grade glycine. In H2 2019, the fluctuation of pharmaceutical-grade glycine eased and the price ranged between USD4,000/t and USD5,000/t. The fluctuations mainly came from the following factors:

- The ex-works price of pharmaceutical-grade is much higher than that of other two grades, and it is not appreciably affected by the market price of tech-grade glycine compared with that of other two grades.
- The knockdown price mainly depends on the bargaining power of trade companies.

Figure 2.5-2 Export prices of various grades of glycine in China, Jan. 2013–Dec. 2019



Source: China Customs & CCM

- Export destination of glycine in China

In 2019, main export destinations of China's glycine include the Netherlands, Germany, India, Thailand, Russia, Japan and South Korea. The Netherlands surpassed Germany and became the largest export destination of China's glycine in 2019, the two countries accounting for 19.6% and 18.0% of China's total export volume of glycine respectively.

Table 2.5-1 China's exports of glycine by destinations, 2019

No.	Country/region	Tech-grade		Food-grade		Feed-grade		Pharmaceutical-grade	
		Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t
1	The Netherlands	139	1,776	9,330	1,871	1,508	1,845	10	2,418
2	Germany	592	1,665	8,466	1,907	1,015	1,689	22	2,145
3	India	979	1,727	3,446	1,681	486	1,848	22	2,008
4	Thailand	88	1,649	3,660	1,812	1,078	1,805	1	10,532
5	Russia	171	2,030	2,956	1,909	660	1,969	347	4,425
6	Japan	27	6,329	3,239	2,119	107	1,875	35	6,416
7	South Korea	90	1,788	2,414	1,939	135	2,265	13	7,953
8	Vietnam	34	1,712	1,573	1,690	447	2,354	21	1,937
9	Spain	654	1,597	1,131	1,625	97	1,751	0	0
10	Belgium	305	4,899	1,140	1,790	20	1,909	133	7,717
11	Australia	376	1,613	645	1,950	61	1,771	7	8,303
12	The US	877	1,923	<1	2,502	15	2,044	0	0
13	Poland	186	1,668	621	1,823	0	0	0	0
14	Indonesia	10	1,630	730	1,932	60	2,102	<1	13,737

No.	Country/region	Tech-grade		Food-grade		Feed-grade		Pharmaceutical-grade	
		Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t
15	The UK	16	2,374	569	1,980	148	2,084	2	3,835
16	Italy	0	0	541	1,865	108	1,629	<1	6,667
17	Brazil	33	2,181	369	1,846	78	2,009	23	2,462
18	France	0	0	492	1,749	9	7,551	<1	12,356
19	Taiwan Province	171	1,527	672	1,887	59	1,767	1	6,871
20	South Africa	32	1,939	243	1,821	2	2,340	7	2,125
21	Mexico	34	1,892	222	1,927	2	2,300	8	2,754
22	Switzerland	0	0	220	1,767	40	1,730	0	0
23	Sweden	0	0	131	2,195	76	1,998	0	0
24	Egypt	<1	4,844	176	1,933	5	1,901	9	3,875
25	Ireland	0	0	160	1,750	0	0	0	0
26	Malaysia	0	0	146	1,930	0	0	1	24,590
27	Argentina	4	2,195	58	2,140	68	2,077	3	3,087
28	Turkey	<1	4,760	117	1,838	6	2,467	4	6,800
29	Nigeria	0	0	115	2,048	2	2,069	0	0
30	Canada	39	2,085	67	2,195	2	2,107	0	0
Others		41	1,994	572	1,915	51	2,192	20	12,236
Total		4,898	1,967	44,221	1,871	6,345	1,891	689	5,182

Note: The data has been rounded.

Source: China Customs & CCM

- Exporter of glycine in China

Glycine producers play a dominant role in glycine export in China, and the export by glycine producers and their related companies took up over 82% in terms of volume during 2017–2019.

Table 2.5-2 China's exports of glycine by exporter, 2019

No.	Exporter	Tech-grade		Food-grade		Feed-grade		Pharmaceutical-grade	
		Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t
1	Hebei Huayang Biological Technology Co., Ltd.*	269	1,568	9,133	1,793	349	1,697	0	3,100
2	Jiangxi Ansun Chemical Technology Co., Ltd.*	0	/	5,321	1,877	1,077	1,884	0	/
3	Hebei Pushi Yongdao Trade Co., Ltd.*	109	1,652	5,267	1,900	340	1,826	0	/

No.	Exporter	Tech-grade		Food-grade		Feed-grade		Pharmaceutical-grade	
		Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t	Volume, tonne	Price, USD/t
4	Hebei Donghua Jiheng Amino Acid Technology Co., Ltd. *	1,171	1,581	3,701	1,835	0	/	0	/
5	Hebei Huaheng Biological Technology Co., Ltd. *	131	1,737	4,161	1,827	20	1,355	0	/
6	Nanchang Newtrend Technology Co., Ltd.*	0	/	2,972	2,034	802	2,119	0	/
7	Shijiazhuang Donghuajian Amino Acids Co., Ltd. *	36	1,614	2,740	1,979	333	1,656	0	/
8	Guang'an Chengyang Bio-tech Co., Ltd. *	0	/	2,614	1,712	0	/	0	/
9	Hebei Granray Bioproducts Co., Ltd. *	92	1,629	401	1,815	1,163	1,684	0	/
10	Shijiazhuang Chiyuan Food Technology Co., Ltd. *	0	/	1,653	2,082	0	/	0	5,882
11	Hebei Harmony Amino Acid Co., Ltd. *	113	1,547	903	1,545	0	/	0	/
12	Shijiazhuang Haitian Amino Acid Co., Ltd. *	502	1,805	347	1,758	88	1,754	0	/
13	Chengdu Shanfeng International Trade Co., Ltd.	830	1,924	0	/	0	/	0	/
14	Xiamen Yuanbaolong Import & Export Co., Ltd.	0	/	653	2,004	0	/	0	/
15	Shanxi Chengxin Chemical Co., Ltd.	0	/	560	1,747	0	/	0	/
16	Hebei Chuncheng Biological Technology Co., Ltd. *	0	/	153	1,870	383	1,750	0	/
17	Hengshui Yangli Commerce Co., Ltd.	60	1,920	463	1,870	10	1,889	0	/
18	Hebei Changhao Biotechnology Co., Ltd. *	0	/	515	1,803	0	/	0	/
19	Jilin Shengrong Chemicals Import & Export Co., Ltd.	210	1,628	99	1,787	191	1,717	0	/
20	Shanghai Yunyuan Trade Co., Ltd.	0	/	0	/	454	1,642	0	/
Others		1,376	2,493	2,566	2,079	1,136	2,294	689	5,183
Total		4,898	1,967	44,221	1,871	6,345	1,891	689	5,182

Note: 1.* Glycine producers or their related companies

2. The data has been rounded.

3. Zhaocounty Granray Bioproducts Co., Ltd. has changed its name to Hebei Granray Bioproducts Co., Ltd.; Jiangxi Ansun Chemical Technology Co., Ltd. has changed its name to Jiangxi Ansun Food Ingredients Co., Ltd.

Source: China Customs & CCM

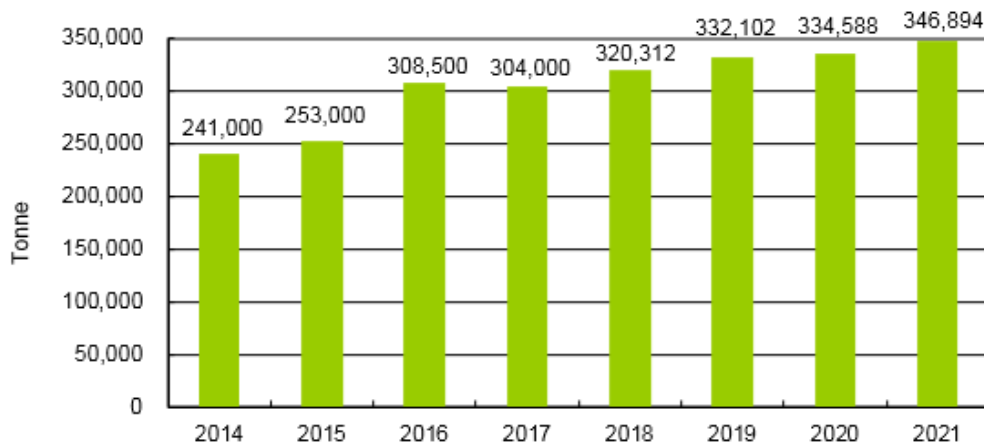
2.6 Demand for glycine in China

2.6.1 Consumption of glycine in China

Major end-use segments of glycine are glyphosate, food, feed and pharmaceutical in China.

The consumption of tech-grade glycine in China increased from 241,000 tonnes in 2014 to 346,894 tonnes in 2021; it kept increasing all these years except in 2017. In 2021, 75.2% of tech-grade glycine was applied in the domestic glyphosate industry.

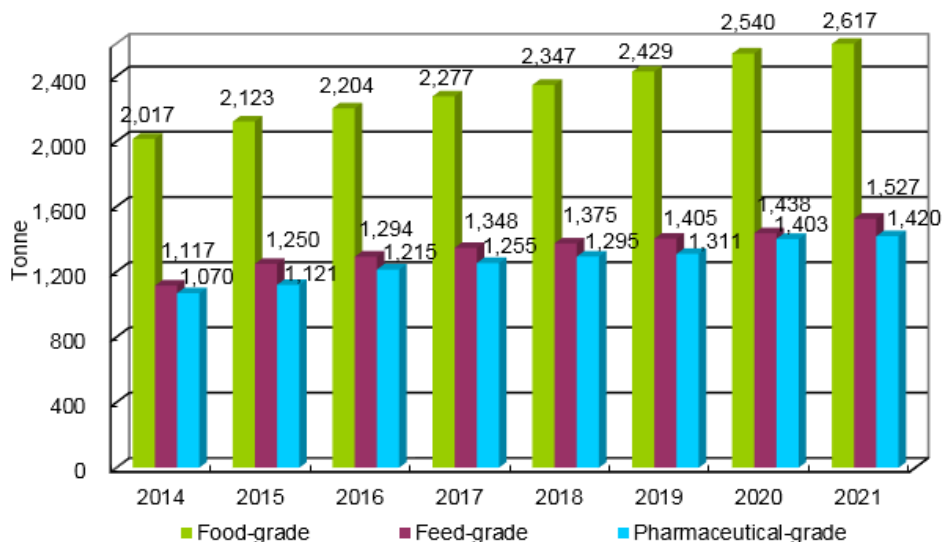
Figure 2.6.1-1 Consumption of tech-grade glycine in China, 2014–2021



Source: CCM

Consumption of food-, feed- and pharmaceutical-grade glycine increased constantly from 2014 to 2021. The consumption of food-grade glycine has increased from 2,017 tonnes in 2014 to 2,617 tonnes in 2021, with a CAGR of 3.8%. Feed-grade glycine consumption increased from 1,117 tonnes in 2014 to 1,527 tonnes in 2021, with a CAGR of 4.6%. Pharmaceutical-grade glycine has always been the smallest end use segment; from 2014 to 2021, its consumption increased from 1,070 tonnes to 1,420 tonnes, with a CAGR of 4.1%.

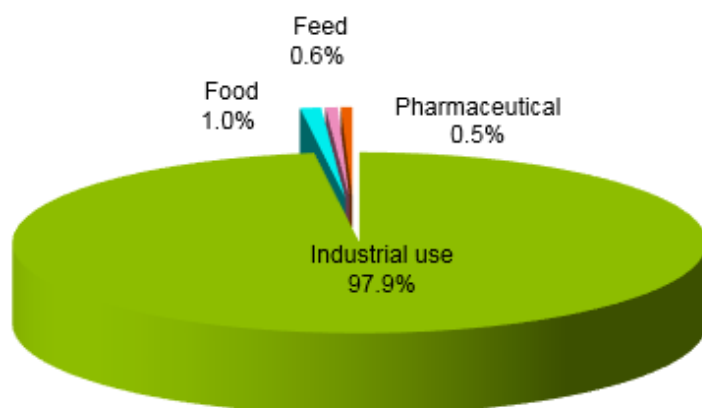
Figure 2.6.1-2 Consumption of various grades glycine in China, 2014–2021



Source: CCM

On the whole, consumption of glycine in industrial use is at absolutely dominant position in glycine consumption in China. It took up 97.9% to the total in 2021, while for food, feed and pharmaceutical uses, their consumption only accounted for about 1.0%, 0.6% and 0.5% respectively.

Figure 2.6.1-3 Consumption pattern of glycine in China by application field, 2021



Source: CCM

2.6.2 Major application segments of glycine in China

2.6.2.1 Glyphosate

Glyphosate is the most important end-use segment of glycine in China, as over 75% of tech-grade glycine is consumed in glyphosate industry in recent years.

China's glyphosate industry has developed rapidly since 2007 with fast increase both in capacity and output. By Dec. 2015, total capacity of glyphosate had tripled to nearly 1 million t/a on 2007 basis. Rapid expansion in capacity led to a huge overcapacity in the industry and increasingly intensified market competition. Living space for small and medium enterprises greatly narrowed. As a result of national supply-side reform and increases in penalties for environmental pollution, capacity of glyphosate has been shrinking.

Glyphosate market started to recover from H2 2016 with increases in output and operating rate for the following reasons:

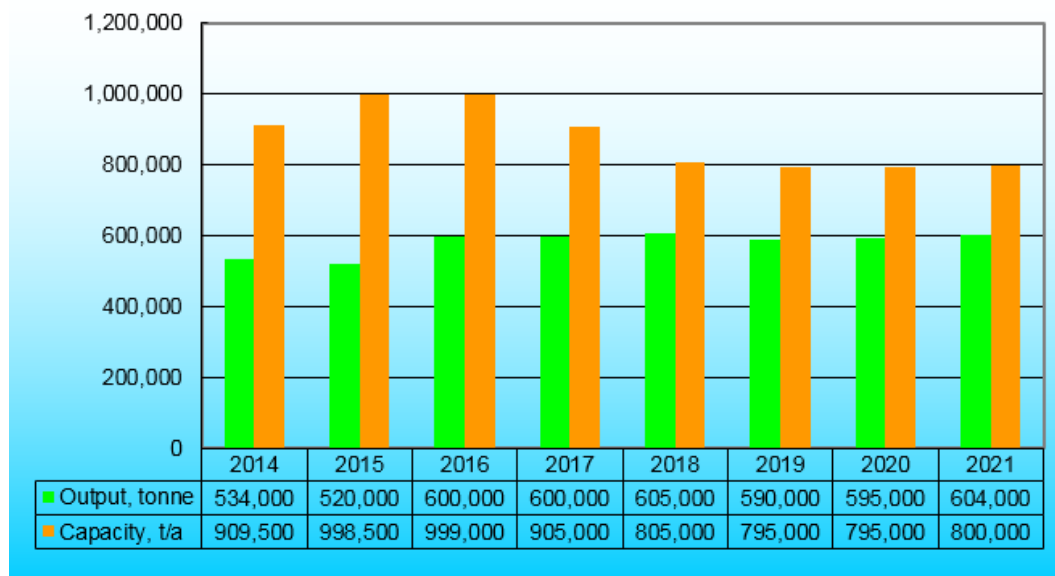
- In H2 2016, as the news spread that environmental inspections would be carried out in some regions, the price of glyphosate rose rapidly. Producers expanded production in succession owing to substantial increase in profit margin.
- China's ban on paraquat AS had led to an increase in demand for glyphosate.
- The US Environmental Protection Agency said it had ruled out the direct relationship between glyphosate and risk of cancer. The European Commission has adopted the act to renew the approval of glyphosate for 5 years. The news was in favor of the glyphosate market and stimulated China's exports of glyphosate.

In 2016–2018, the number of glyphosate producers in China decreased from about 30 to less than 20, and the national glyphosate capacity also declined correspondingly, due to the nationwide centralized environmental inspections and production safety inspections.

In 2019–2020, the capacity of glyphosate in China kept unchanged, and the output increased a little.

In 2021, both the capacity and output of glyphosate rose slightly in China, with the capacity reaching 800,000 t/a and the output reaching 604,000 tonnes.

Figure 2.6.2.1-1 Capacity and output of glyphosate technical in China, 2014–2021



Source: CCM

Table 2.6.2.1-1 Consumption of glycine in glyphosate in China, 2014–2021, tonne

Year	2014	2015	2016	2017	2018	2019	2020	2021
Output of glyphosate technical (glycine route)	361,800	387,100	451,000	437,900	444,000	442,000	452,000	449,000
Consumption of glycine	210,000	225,000	262,000	252,000	258,000	257,000	263,000	261,000

Source: CCM

Currently, three production routes are adopted in glyphosate industry in China, namely glycine route, IDAN route and DEA route. Output of glyphosate technical produced through glycine route, the dominated one, accounted for 72%–76% of the total glyphosate output in China in 2017–2021.

Table 2.6.2.1-2 Major glyphosate producers adopting glycine route in China, 2021

No.	Producer	Abbreviation	Status, 2021	Capacity 2021, t/a	Output, tonne				
					2017	2018	2019	2020	2021
1	Sichuan Leshan Fuhua Tongda Agro-chemical Technology Co., Ltd.	Fuhua Tongda	Active	153,000	130,000	126,000	129,000	123,000	126,000
	Nantong Jiangshan Agrochemical & Chemical Co., Ltd. *	Nantong Jiangshan	Active	30,000	30,000	30,000	29,000	30,000	29,000
2	Hubei Trisun Chemical Co., Ltd.	Hubei Trisun	Active	130,000	122,900	110,000	110,000	115,000	122,000
	Inner Mongolia Xingfa Technology Co., Ltd.	Inner Mongolia Xingfa	Active	50,000	25,000	29,000	35,000	36,000	28,000
3	Zhejiang Wynca Chemical Group Co., Ltd.	Zhejiang Wynca	Active	30,000	5,000	31,000	31,000	31,000	30,000
	Zhenjiang Jiangnan Chemical Co., Ltd.	Zhenjiang Jiangnan	Active	50,000	50,000	50,000	50,000	50,000	50,000

No.	Producer	Abbreviation	Status, 2021	Capacity 2021, t/a	Output, tonne				
					2017	2018	2019	2020	2021
4	Henan HDF Chemical Co., Ltd.	Henan HDF	Active	30,000	25,000	28,000	18,000	27,000	25,000
5	Jiangxi Jinlong Chemical Co., Ltd.	Jiangxi Jinlong	Active	20,000	20,000	20,000	20,000	20,000	20,000
6	Anhui Dongzhi Guangxin Agrochemical Co., Ltd.	Anhui Guangxin	Active	20,000	20,000	20,000	20,000	20,000	19,000
Others				35,000	10,000	0	0	0	0
Total				548,000	437,900	444,000	442,000	452,000	449,000

Note: Producers with * have at least two routes of glyphosate production, and here only the capacity and output of glycine route is presented.

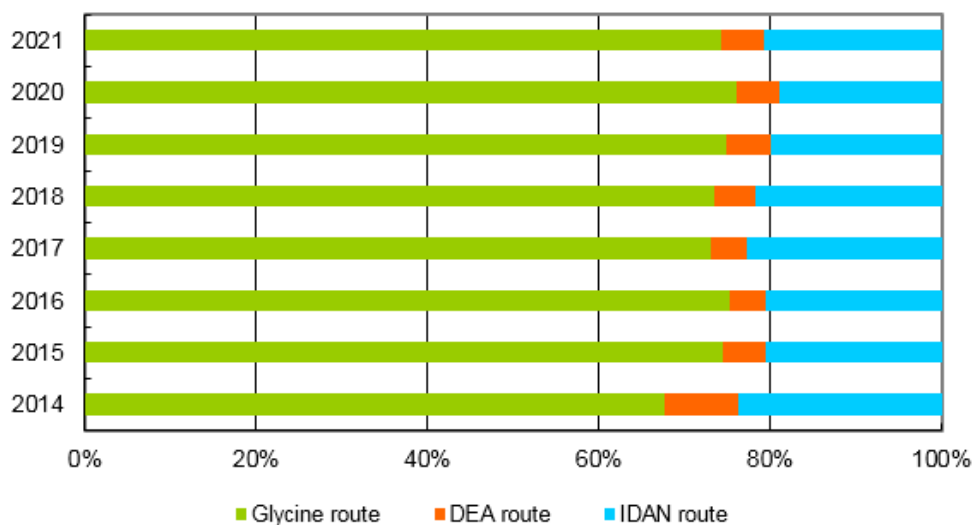
Source: CCM

The popularity of glycine route for glyphosate production is attributed to the following factors:

- **Simple process:** Compared with the other two routes, glycine route is quite simple and easier for new comers to master.
- **Abundant raw materials:** All raw materials including glycine, paraformaldehyde and dimethyl phosphite are in abundant supply in China.
- **Mature technology:** Since developed in 1987, glycine route has been widely applied in China for years. The whole process is quite mature at present, and the byproduct recycling technology has been developing and helped reduce the cost in recent years.
- **Establishment of complete industrial chain:** These key players try to build complete industrial chain from upstream materials (chloroacetic acid, glycine, phosphorus trichloride, dimethyl phosphite, or paraformaldehyde) to final products (glyphosate formulations) and byproducts (methylal, methyl chloride, phosphorous acid, sodium salts, ammonium salts, or acids) to reduce the cost and strengthen the competitiveness.

Glycine route will still have a good future in China in the next five years, though glycine route faces challenges in the aspect of environmental protection as it causes severer water pollution than other routes. Output of glyphosate produced by glycine route will maintain its leading position and is expected to keep at a high level.

Figure 2.6.2.1-2 Output structure of glyphosate technical in China by production route, 2014–2021



Source: CCM

Most glyphosate producers have signed contracts with glycine producers to guarantee the supply of glycine in China. Large-scale glyphosate producers such as Zhejiang Wynca and Jiangxi Jinlong, prefer signing contracts with different glycine producers.

Table 2.6.2.1-3 Main glycine producers and consumers in glyphosate industry in China, 2021

No.	Glycine producer	Glycine consumer
1	Hebei Donghua	Zhejiang Wynca, Nantong Jiangshan, Anhui Guangxin, etc.
2	Hubei Trisun	Hubei Trisun, Jiangxi Jinlong, Inner Mongolia Xingfa, etc.
3	Fuhua Tongda	Fuhua Tongda
4	Linyi Hongtai	Zhejiang Wynca
5	Inner Mongolia Xingfa	Inner Mongolia Xingfa
6	Henan HDF	Henan HDF

Source: CCM

2.6.2.2 Food

In food industry, glycine is mainly used as a nutritional supplement in food additives to improve flavor. Only 2,617 tonnes of food-grade glycine, taking up 5.3% of the national output of food-grade glycine, was applied in food industry in 2021, 77 tonnes more than that in 2020.

Table 2.6.2.2-1 Main end-use segments of glycine in China's food industry

No.	End-use segment	Addition ratio, %	Usage
1	Minced fish products, peanut butter	1.00–2.00	Restraining function of colon bacillus and other Bacillus species
2	Alcoholic drinks	Wine	Flavoring agents and sweetening agents
3		Whisky	
4		Champagne	
5	Soup spices	2.00	Flavoring agents, with prawn and cuttlefish flavor
6	Liquor pickled products	1.00	
7	Salted preserves	0.3–0.7	Buffer solutions and acidity regulators
8	Pickles	0.05–0.5	
9	Creams	0.1–0.5	Prolonging storage life for three to four times
10	Cheeses	0.3–0.7	
11	Bakery products	0.5	Stabilizing agents with the function of antioxidation
12	Semolina	0.1–0.5	

Source: CCM

As a synthetic amino acid, if taken in excess, glycine cannot be absorbed by human, it will also break the balance with other amino acids that being absorbed, and have an adverse effect upon health. According to food safety national standard GB 2760, glycine cannot be used in dairy products in China. However, in order to reduce production cost, some milk beverage producers once used glycine instead of milk powder to increase the content of protein. After rectification, this rarely happens now.

2.6.2.3 Feed

In feed industry, glycine is mainly used as a nutritional supplement in feed additives and feed attractants. About 1,527 tonnes of feed-grade glycine, was applied in feed industry in 2021, up 6.2% year on year; the volume constitutes 16.5% of the national output of feed-grade glycine.

Glycine used as a feed additive can not only improve nutrition level, but also have the effects of antioxidation and prolonging the shelf life of feed. In China, glycine is mainly used in cattle feed, sheep feed and chicken feed, with an addition ratio of 0.07%.

Glycine used as a feed attractant has the following advantages:

Weight gains

It can improve aquatic animal food intake and effectively accelerate the growth of animals. Usually, the glycine addition ratio is about 0.2%–1.5%.

Feed saving

As a better feed attractant, before glycine feed falls into the bottom, aquatic animals will soon eat up the feed. Therefore, it makes efficient use of feed to avoid waste.

Raise feed nutrition level

Tests show that one unit glycine nutritional value equals 3.5 unit methionine nutritional value.

Entrapping agent

People use glycine feed to entrap fish, and the fish capture rate can reach 85%.

2.6.2.4 Pharmaceutical

Glycine is widely used in pharmaceutical industry, applied in protective agents, stabilizing agents, amino acid nutritional injection solutions and intermediates of some medicaments, etc. About 1,420 tonnes of pharmaceutical-grade glycine, accounting for 64.8% of the national output of pharmaceutical-grade glycine, was applied in pharmaceutical industry in 2021, not much different from 2020.

Table 2.6.2.4-1 Main end-use segments of glycine in China's pharmaceutical industry

No.	End-use segment	Addition ratio, %	Usage
1	Freeze-dry preparation	2.0	Protective agents
2	Glycyrrhetic acid	1.9	
3	Rescinnamine injection	2.0	Stabilizing agents
4	Bleomycin Injection	0.1	
5	Glycine irrigation	1.5	Amino acid injection solutions
6	Oral solution	0.09	
7	Propacetamol hydrochloride	49.7	Intermediates of some medicaments
8	Compound preparation of calcium carbonate	30.0	
9	Glutamic acid, alanine acid and glycine acid capsules	11.0	

Source: CCM

3 Forecast on glycine in China, 2022–2026

3.1 Influencing factors

Major factors concentrate on the following aspects. Glyphosate market will still remain as the most important influencing factor for the development of Chinese glycine industry in the future.

Table 3.1-1 Major factors influencing China's glycine industry

No.	Impact of development	Glycine industry
1	Glyphosate market	The market size of glyphosate, especially glyphosate produced via glycine route, will greatly affect glycine, and glyphosate produced via glycine route will face great challenges from that via the IDAN route and the DEA route.
2	Production technology	Only Guang'an Chengxin (formerly Guang'an Chengyang) adopts Hydantion process, which will lead to great challenges to glycine producers adopting the chloroacetic acid ammonolysis process if this technology will be improved and become mature in the future.
3	Location limitation	Policy on transportation of hypertoxic chemicals including chlor-alkali, chloroacetic acid and hydrogen cyanide (upstream materials of glycolonitrile) is very strict in China. Glycine production by the chloroacetic acid ammonolysis process is therefore limited to be distributed in the places that are abundant in raw materials of chlor-alkali and chloroacetic acid.

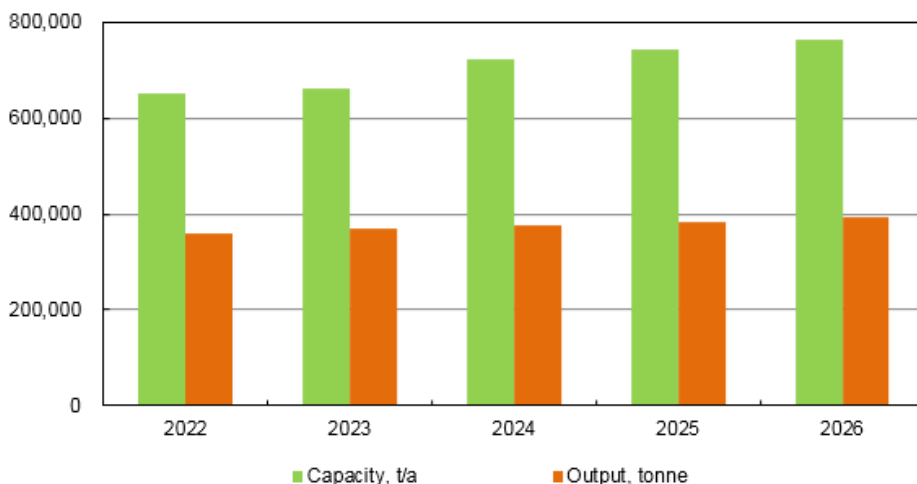
Source: CCM

3.2 Forecast on glycine supply in China

The national capacity of tech-grade glycine is estimated to be over 760,000 t/a in 2026, if those potential glycine projects proceed smoothly.

China's output of tech-grade glycine will reach about 392,900 tonnes in 2026, with a CAGR of 2.2% during 2022–2026. Glycine route glyphosate will maintain its leading position in China in the coming five years, ensuring the increasing demand for tech-grade glycine from glyphosate industry.

Figure 3.2-1 Predicted capacity and output of tech-grade glycine in China, 2022–2026



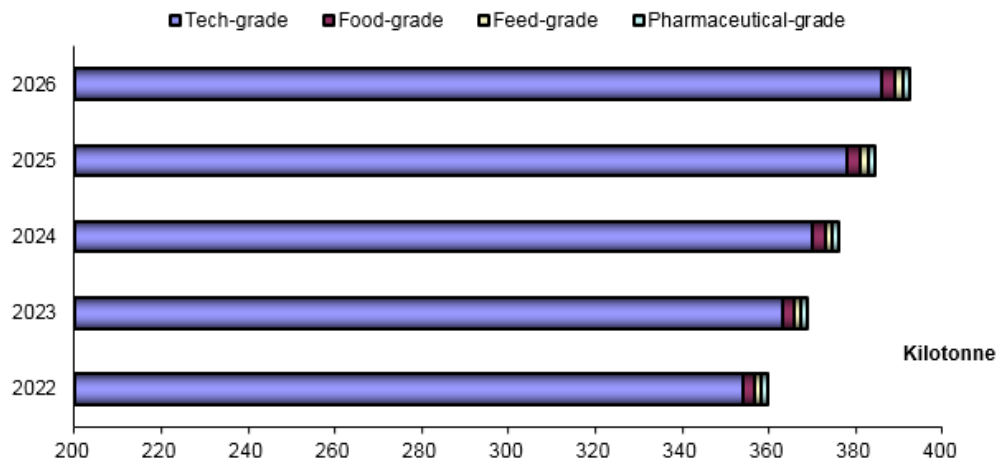
Source: CCM

3.3 Forecast on glycine demand in China

Domestic demand for glycine from food, feed and pharmaceutical fields has kept increasing stably year by year. Growing demand for glycine from these three fields is expected to continue due to good properties and relatively wide application of glycine with these three grades, but it has limited impact on domestic glycine market structure since the tech-grade glycine still takes up nearly 98% of Chinese glycine market.

With the promotion of GM crops especially GM soybean and corn, demand for glyphosate will keep increasing in the coming few years, which will ensure sustainably robust demand for glycine in the coming five years. China's demand for tech-grade glycine is estimated to reach 386,000 tonnes in 2026, with a CAGR of 2.2% during 2022–2026.

Figure 3.3-1 Predicted market demand for glycine in China by grade, 2022–2026



Source: CCM

4 Investment opportunities and suggestions

Table 4-1 Strengths and weaknesses of Chinese glycine industry

Strength	Weakness
<ul style="list-style-type: none"> - Large scale production (not too many producers, high industrial concentration) - Relatively complete industrial chain - Sufficient supply of raw materials such as chlor-alkali and chloroacetic acid, which is helpful for cost control - Growing demand for glycine from glyphosate industry due to increasing global demand for glyphosate 	<ul style="list-style-type: none"> - Tech-grade glycine highly depended on glyphosate market - Food-, feed- and pharmaceutical-grade glycine highly depended on overseas market - Less-advanced technology—the chloroacetic acid ammonolysis process is taken by almost all producers - Oversupply of glycine

Source: CCM

China's glycine industry will face many challenges in the future, and China shall accelerate the integration of the industry.

Major challenges for the industry are as follows:

- Poor profit

It is one of the most important factors influencing the operating rate, and slim profit is unlikely to change in the short run.

- Oversupply

With blind expansion, oversupply has been aggravated in general, and the domestic glycine producers have weak bargaining power with glyphosate producers.

- High dependence on glyphosate

No other potential applications have been developed, and domestic glycine industry becomes increasingly passive and susceptible when facing market risks.

- More investment in environmental protection

Glycine producers will spend a lot on pollutant treatment due to stricter environmental policies released by the Chinese government.

Integration of China's glycine industry is an opportunity for both large glycine and glyphosate producers. Some small glycine producers have suspended or stopped glycine production, and more and more small- or medium-sized glycine producers will be eliminated in the coming few years. Thus, it offers a chance for top domestic producers to merge with these small- or medium-sized companies to enhance competitiveness, and for top glyphosate producers to build a complete industrial chain for cost reduction.

From June 2021 to June 2022, China's glyphosate and glycine industries have experienced the most prosperous market in the past eight years. Looking forward to 2026, large glyphosate enterprises may merge with glycine producers and continue to integrate and improve the industrial chain.

5 Profile of key glycine producers in China

5.1 Hebei Donghua Chemical Group

Address: No. 89 Erhuan East Road, Shijiazhuang City, Hebei Province 050037, P. R. China

Tel: +86-311-83097676, 66619888, 83097811; +86-318-6109699, 6109877

Fax: +86-311-85318041, +86-318-6109698

E-mail: donghua@glycine.com.cn

Website: www.glycine.com.cn, www.dhjhglycine.com, www.chiyuenchemical.com

1. Company background

Hebei Donghua Chemical Group (Hebei Donghua), founded in 1979, is composed of 5 related companies (sales companies excluded), among which 3 are engaged in tech-grade glycine production.

- **Shijiazhuang Donghua Jinlong Chemical Co., Ltd.** has production capacity of 90,000 t/a tech-grade glycine and 10,000 t/a glycine of other three grades.

- **Hebei Donghua Jiheng Chemical Co., Ltd.**, established in 2005, produces tech-grade glycine only with capacity of 70,000 t/a.

- **Hebei Donghua Jiheng Amino Acid Technology Co., Ltd.** produces glycine of other three grades with capacity of 15,000 t/a.

- **Shijiazhuang Chiyuen Chemical Co., Ltd.** (the former Hebei Donghuajian Chemical Co., Ltd.) has two tech-grade glycine production bases with total capacity of 32,000 t/a.

- **Shijiazhuang Chiyuen Food Technology Co., Ltd.**, established in 2015, produces glycine of other three grades with capacity of 10,000 t/a.

2. Product species

The main products of Hebei Donghua are as follows:

- Glycine: tech-grade, food-grade, feed-grade, pharmaceutical-grade

- Chloroacetic acid

- Zinc glycinate, ferrous glycinate, ferric glycinate, magnesium glycinate, calcium glycinate, sodium glycinate

- Glycine phosphate, glycine fumarate, glycine citrate

- Lysine carbonate

- Hydantoin

- Di-sodium glycine carbonate (Di-SGC)

- Mono-sodium glycine carbonate (Mono-SGC)

3. Situation of glycine

Table 5.1-1 Capacity and output of glycine in Hebei Donghua, 2017–2021

Year	2021		2020		2019		2018		2017	
	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
Capacity, t/a	192,000	35,000	192,000	35,000	192,000	35,000	192,000	31,000	182,000	31,000
Output, tonne	130,000	20,000	130,000	20,000	130,000	20,000	140,000	20,000	130,000	20,000

Note: Others include food-grade, feed-grade and pharmaceutical-grade.

Source: CCM

Shijiazhuang Donghua Jinlong Chemical Co., Ltd.'s 10,000 t/a tech-grade glycine was built up in May 2018 and put into trial production in September 2018. Shijiazhuang Chiyuen Food Technology Co., Ltd.'s 10,000 t/a glycine (the other three grades) was put into production in May 2019.

Hebei Donghua produces chloroacetic acid as well, so the raw material supply is guaranteed and the production cost of its glycine could be reduced greatly.

Its glycine is sold all over the country. The company is highly recognized by key glyphosate producers in China such as Zhejiang Wynca, Nantong Jiangshan, for good product quality and abundant supply.

The company has passed international certifications such as ISO22000, ISO9001, ISO14001, OHSAS18001, FAMI-QS, MUI-HALAL, KOSHER and REACH, and its products are exported to Thailand, India, Japan, Switzerland, Germany, etc.

5.2 Hubei Trisun Chemical Co., Ltd. & Inner Mongolia Xingfa Technology Co., Ltd.

Hubei Trisun Chemical Co., Ltd.

Address: No. 66-4 Xiaoting Street, Xiaoting District, Yichang City, Hubei Province 443000, P. R. China
 Tel: +86-717-6530551, 6760659
 Fax: +86-717-6760308
 E-mail: sales@xingfagroup.com

1. Company background

Hubei Trisun Chemical Co., Ltd. (Hubei Trisun) is 76.87% owned by Hubei Xingfa Chemicals Group Co., Ltd.

In 2018, Hubei Trisun completed the acquisitions of Yichang Jinxin Chemical Co., Ltd. (deregistered already) and Inner Mongolia Xingfa Technology Co., Ltd. (Inner Mongolia Xingfa, formerly known as Inner Mongolia Tenglong Fine Chemical Co., Ltd.)

Its key products include:

- Glyphosate: 130,000 t/a
- Glycine: 100,000 t/a
- Chloroacetic acid: 160,000 t/a
- Urotropine: 18,000 t/a
- Phosphorus trichloride: 210,000 t/a
- Calcium chloride: 80,000 t/a
- Others

2. Situation of glycine

Table 5.2-1 Capacity and output of glycine in Hubei Trisun, 2017–2021

Year	2021	2020	2019	2018	2017
Capacity, t/a	100,000	100,000	100,000	100,000	100,000
Output, tonne	88,000	80,000	84,000	73,000	83,000

Source: CCM

Hubei Trisun produces tech-grade glycine only. Its glycine is firstly supplied to itself and Inner Mongolia Xingfa, and the rest is sold to other glyphosate producers.

Its key customers include Inner Mongolia Xingfa, Jiangxi Jinlong, etc.

Inner Mongolia Xingfa Technology Co., Ltd.

Address: Wuda Industrial Park, Wuhai Economic Development Zone, Wuhai City, Inner Mongolia Autonomous Region 016040, P. R. China
 Tel: +86-473-6988121, 6910502
 Website: www.tlonggroup.com

1. Company background

Inner Mongolia Xingfa mainly produces glyphosate technical and its intermediates.

Its key products include:

- Glyphosate technical: 50,000 t/a
- Glycine: 10,000 t/a
- Chloroacetic acid: 10,000 t/a
- Dimethyl phosphate: 54,000 t/a
- Phosphorus chloride: 60,000 t/a

2. Situation of glycine

Inner Mongolia Xingfa produces tech-grade glycine only, and its 10,000 t/a glycine production line was put into production in 2015. All of its glycine is consumed by itself for the production of glyphosate technical. The glycine line was operated at full capacity during 2017–2021.

Inner Mongolia Xingfa's EIA report of "organic silicon new material integrated and recycling project" was published in April 2021, and this project includes 50,000 t/a glyphosate technical, 60,000 t/a glycine, 90,000 t/a chloroacetic acid, etc. with a proposed construction period of 24 months.

5.3 Sichuan Leshan Fuhua Tongda Agro-chemical Technology Co., Ltd.

Address: Qiaogou town, Wutongqiao District, Leshan City, Sichuan Province 614800, P. R. China

Tel: +86-833-3186008, +86-833-3352686

Fax: +86-833-3359989

E-mail: fhny@fuhuagroup.com

Website: www.fuhua-tongda.com

1. Company background

Sichuan Leshan Fuhua Tongda Agro-chemical Technology Co., Ltd. (Fuhua Tongda), established in Dec. 2007, specializes in R&D, production and sale of glyphosate and related agrochemicals.

Its products include:

- Glycine: 40,000 t/a
- Glyphosate: 153,000 t/a
- Ion-exchange membrane caustic soda: 500,000 t/a
- Paraformaldehyde: 60,000 t/a
- Hydrogen peroxide: 120,000 t/a
- Sodium tripolyphosphate: 30,000 t/a
- Glufosinate-ammonium: 6,000 t/a

2. Situation of glycine

Table 5.3-1 Capacity and output of glycine in Fuhua Tongda, 2017–2021

Year	2021	2020	2019	2018	2017
Capacity, t/a	40,000	40,000	40,000	40,000	40,000
Output, tonne	26,000	25,000	25,000	22,000	20,000

Source: CCM

Fuhua Tongda started producing tech-grade glycine in 2016, and its glycine is used for its own glyphosate production. It also purchases glycine from other glycine producers such as Hebei Donghua. Its previously planned second phase of the 80,000 t/a tech-grade glycine project will no longer be built.

5.4 Linyi Hongtai Chemical Co., Ltd.

Address: Huaihai Road, Economic Development Zone, Ju'nan County, Linyi City, Shandong Province 276600, P. R. China
Tel: +86-539-7858888
Person to contact: Mr. Wang
E-mail: hongtailxl@163.com

1. Company background

Linyi Hongtai Chemical Co., Ltd. (Linyi Hongtai) was established in 2009 with a registered capital of RMB100 million.

Its products include:

- Glycine: 70,000 t/a
- Hydrochloric acid: 112,000 t/a
- Ammonium chloride: 56,000 t/a
- Calcium chloride: 100,000 t/a

2. Situation of glycine

Table 5.4-1 Capacity and output of glycine in Linyi Hongtai, 2017–2021

Year	2021	2020	2019	2018	2017
Capacity, t/a	70,000	70,000	50,000	50,000	50,000
Output, tonne	35,000	35,000	28,000	30,000	30,000

Source: CCM

Linyi Hongtai produces tech-grade glycine only. The company has expanded its glycine capacity from 50,000 t/a to 70,000 t/a, and it has four glycine production lines with the capacity of 10,000 t/a, 20,000 t/a, 20,000 t/a and 20,000 t/a respectively.

Its customers include Zhejiang Wynca and Nantong Jiangshan.

5.5 Guang'an Chengxin Chemical Co., Ltd.

Address: Xinqiao Industrial Park, Guang'an District, Guang'an City, Sichuan Province 638000, P. R. China
Tel: +86-826-2820015, 2820006; +86-311-85695996
E-mail: guanganchengxin@126.com, guanganxiaoshou@163.com
Website: www.guanganchengxin.com

1. Company background

Guang'an Chengxin Chemical Co., Ltd. (Guang'an Chengxin) acquired Guang'an Chengyang Bio-tech Co., Ltd. (Guang'an Chengyang) in March 2019. Two projects (30,000 t/a glycine, 2,000 t/a food additives) of Guang'an Chengyang were merged into Guang'an Chengxin.

Key products of Guang'an Chengxin include:

- 20,000 t/a Glyphosate technical
- 15,000 t/a PMIDA
- 25,000 t/a IDAN
- 50,000 t/a Formaldehyde
- 30,000 t/a Glycine
- 75,000 t/a Glycolonitrile
- Others

2. Situation of glycine

Table 5.5-1 Capacity and output of glycine in Guang'an Chengxin, 2017–2021

Year	2021		2020		2019		2018		2017	
	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
Capacity, t/a	20,000	8,000	20,000	8,000	20,000	8,000	20,000	8,000	20,000	8,000
Output, tonne	17,000	2,500	17,000	2,500	17,000	2,500	15,000	2,500	15,000	1,400

Note: Others include food-grade, feed-grade and pharmaceutical-grade.

Source: CCM

Guang'an Chengxin's 30,000 t/a glycine production lines (20,000 t/a tech-grade and 10,000 t/a food-grade) were built up and put into trial production in Nov. 2015. It reformed its 10,000 t/a food-grade glycine production line in 2017, and the current lines are 8,000 t/a food-grade glycine, 500 t/a food-grade sodium ferrocyanide, 500 t/a food-grade potassium ferrocyanide, 500 t/a food-grade disodium ethylene diamine tetraacetate, and 500 t/a food-grade ferric sodium edelate.

Guang'an Chengxin is the only glycine producer that adopts the Hydantion process in China, and the key raw material—glycolonitrile is produced by itself.

5.6 Hebei Huaheng Biological Technology Co., Ltd.

Address: No. 777 Xinghua South Street, Jizhou District, Hengshui City, Hebei Province 053200, P. R. China

Tel: +86-318-8628255

Fax: +86-318-8628286

E-mail: jizhouhuaheng@163.com

Website: www.hebeihuaheng.com/

1. Company background

Hebei Huaheng Biological Technology Co., Ltd. (Hebei Huaheng), established in Feb. 2011, is a subsidiary of Jizhou Huaheng Group, which is comprised of Hebei Huaheng and Hebei Gerunde Biological Technology Co., Ltd.

Hebei Huaheng focuses on the R&D and production of amino acids. Its products include glycine, L-lysine hydrochloride, DL-methionine, L-threonine, L-glutamine acid, L-cysteine, L-cysteine hydrochloride, L-alanine and DL-alanine.

The company has got the certificates of FSSC22000, ISO22000, ISO9001:2008, Kosher and Halal.

2. Situation of glycine

Table 5.6-1 Capacity and output of glycine in Hebei Huaheng, 2017–2021

Year	2021		2020		2019		2018		2017	
	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
Capacity, t/a	22,000	30,000	22,000	30,000	22,000	30,000	22,000	30,000	22,000	30,000
Output, tonne	5,000	7,500	5,000	7,300	5,000	6,200	4,000	6,600	3,000	8,800

Note: 1.Capacity and output of glycine of Hebei Gerunde Biological Technology Co., Ltd. is included. 2.Others include food-grade, feed-grade and pharmaceutical-grade.

Source: CCM

Hebei Gerunde Biological Technology Co., Ltd. (Hebei Gerunde), Hebei Huaheng's brother company, began to build 22,000 t/a tech-grade and 20,000 t/a food-grade glycine production facilities in 2014, which were put into operation in 2017. Hebei Gerunde proposed a technological transformation project (adjusting 20,000 t/a

food-grade glycine to 10,000 t/a food-grade glycine, 5,000 t/a pharmaceutical-grade glycine, and 5,000 t/a guanidinoacetic acid) in August 2020, which had not been completed by June 2022.

5.7 Henan HDF Chemical Co., Ltd.

Address: Fine Chemical Zone, Zhangpan Town, Xuchang County, Henan Province 461000, P. R. China
Tel: +86-374-5699599
Fax: +86-374-5699618
Person to contact: Mr. Sheng
E-mail: sales@xcdfchem.com
Website: www.xcdfchem.com

1. Company background

Henan HDF Chemical Co., Ltd. (Henan HDF), former Xuchang Dongfang Chemical Co., Ltd., is a well-known chemical enterprise in China and mainly engages in the R&D, production and sale of fine chemicals and pesticides. It covers an area of 33 hectares and has about 370 employees, including 63 engineering technicians in different fields. The registered capital of the company was RMB76.11 million as of June 2022.

Its products include:

- Glycine: 15,000 t/a
- Chloroacetic acid: 15,000 t/a
- Glyphosate technical: 30,000 t/a
- Dimethyl phosphate: 30,000 t/a

2. Situation of glycine

Table 5.7-1 Capacity and output of glycine in Henan HDF, 2017–2021

Year	2021	2020	2019	2018	2017
Capacity, t/a	15,000	15,000	15,000	15,000	15,000
Output, tonne	11,000	10,000	11,000	12,000	10,000

Source: CCM

Henan HDF produces tech-grade glycine only and its glycine is mainly consumed by itself for the production of glyphosate technical. Henan HDF published a 6,000 t/a chloroacetic acid and 20,000 t/a glycine expansion plan in June 2019, but this project had not been built as of June 2022.

5.8 Hebei Chuncheng Biological Technology Co., Ltd.

Address: No.14 Weiyi Road, Salt Chemical Park, Ningjin County, Xingtai City, Hebei Province 054000, P. R. China
Tel: +86-311-66561796
E-mail: glycine@hbccbio.com
Website: www.hbccbio.com

1. Company background

Hebei Chuncheng Biological Technology Co., Ltd. (Hebei Chuncheng), was established in March 2015, covering an area of 67,000 square meters. The company's main products include glycine, L-alanine, DL-alanine, L-lysine hydrochloride, L-threonine, L-methionine, L-cysteine hydrochloride, L-phenylalanine, L-glutamic acid, L-cystine, L-cysteine, L-arginine, L-leucine, L-tryptophan, D-xylose, L-aspartic acid and so on. The company has been certified to ISO9001-2015, ISO22000-2005, FSSC 22000, Kosher and Halal.

2. Situation of glycine

Table 5.8-1 Capacity and output of glycine in Hebei Chuncheng, 2017–2021

Year	2021		2020		2019		2018		2017	
	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
Capacity, t/a	10,000	3,000	10,000	3,000	10,000	3,000	10,000	3,000	10,000	3,000
Output, tonne	3,500	2,000	5,000	1,500	5,000	1,000	5,000	1,000	0	1,000

Note: Others include food-grade, feed-grade and pharmaceutical-grade.

Source: CCM

Hebei Chuncheng's production lines of 10,000 t/a tech-grade glycine and 3,000 t/a food-grade glycine were built up in early 2017. Its 2nd phase 14,000 t/a tech-grade and 3,000 t/a food-grade glycine has no further information yet.

5.9 Shandong Zhenxing Chemical Industry Co., Ltd.

Address: No. 1739 Luxing Road, Huanglou Town, Qingzhou City, Shandong Province 262517, P. R. China

Tel: +86-536-3531025, 3532868

Fax: +86-536-3531264

Person to contact: Mr. Zhu

E-mail: 401954173@qq.com

Website: www.sdzxhg.com

1. Company background

Shandong Zhenxing Chemical Industry Co., Ltd. (Shandong Zhenxing), former Shandong Zhenxing Chemical Plant, was established in 1985, covering an area of 46,000 square meters.

The company engages in the production and sale of white carbon black, glycine (10,000 t/a), hydrochloric acid (12,000 t/a), chloroacetic acid (15,000 t/a) and aqueous ammonia (1,800 t/a).

2. Situation of glycine

Table 5.9-1 Capacity and output of glycine in Shandong Zhenxing, 2017–2021

Year	2021	2020	2019	2018	2017
Capacity, t/a	10,000	10,000	10,000	10,000	10,000
Output, tonne	500	1,000	1,000	1,000	2,000

Source: CCM

Shandong Zhenxing produces tech-grade glycine only. All of its tech-grade glycine is sold to domestic companies. Since May 2021, it suspended production under stricter environmental protection policy.

5.10 Hebei Huayang Biological Technology Co., Ltd.

Address: No. 645 Fuyang East Road, Jizhou District, Hengshui City, Hebei Province 053200, P. R. China
Tel: +86-318-8638866, 8638886
Fax: +86-318-8638856, 8638858
E-mail: trade@huayangchems.com
Website: www.huayangchems.com

1. Company background

Hebei Huayang Biological Technology Co., Ltd. (Hebei Huayang), former Jizhou Huayang Chemical Co., Ltd., was established in April 1987 with a registered capital of RMB50 million.

Hebei Huayang obtained the import and export license in Sept. 2001, and got the certificates of Kosher and Halal in Aug. 2002 and ISO9001:2000 in Sept. 2002.

Hebei Huayang Group has three production bases with a total area of 180,000 square meters, owning more than 380 staffs as of June 2022. The company mainly produces amino acid series products, including glycine, lysine salt, L-threonine, DL-methionine, D (L) L-cysteine and other food- and pharmaceutical-grade amino acid products.

2. Situation of glycine

Table 5.10-1 Capacity and output of glycine in Hebei Huayang, 2017–2021

Year	2021		2020		2019		2018		2017	
	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others	Tech-grade	Others
Capacity, t/a	6,000	11,000	6,000	11,000	6,000	11,000	6,000	11,000	6,000	11,000
Output, tonne	3,000	10,000	3,000	11,000	5,000	10,000	5,000	11,000	4,000	11,000

Note: Others include food-grade, feed-grade and pharmaceutical-grade.

Source: CCM

Hebei Huayang purchased tech-grade glycine to produce food-grade glycine and pharmaceutical-grade glycine before 2008.

In March 2008, its new 6,000 t/a tech-grade glycine unit was put into production. And all the four grades of glycine are produced.

Cangzhou Huachen Biological Technology Co., Ltd., a subsidiary of Hebei Huayang, was established in Oct. 2017. It proposed to construct a glycine project (30,000 t/a tech-grade, 30,000 t/a food-grade) in Dec. 2019. The first phase of this project had been completed and put into production in Nov. 2021.

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17th Floor, Huihua Commercial & Trade Building, No. 80 Xianlie Zhong Road Guangzhou,
510070, P.R.China

Website: <http://www.cnchemicals.com>

Tel: +86-20-37616606

Fax: +86-20-37616968

Email: econtact@cnchemicals.com