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2023-2032 China agricultural outlook analysis

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DCZ Expert Study

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1. Introduction

The Market Early Warning Expert Committee and the Department of Market and Informatization of the Chinese Ministry of Agricultural and Rural Affairs (MARA) published the 2023-2032 *China Agricultural Outlook Report* on 20 April with an unveiling conference at CAAS (Chinese Academy of Agricultural Sciences) campus in Beijing. The annually released *Outlook* reviews annual agricultural production and consumption trends and presents projections on the development of agricultural supply, demand, prices, and trade flows for key agricultural commodities such as oilseeds, staple crops, cash crops, as well as animal products.

This analysis reviews major themes and projections in the *Outlook* and discusses its implications and limitations.

2. Methods

The *China Agricultural Outlook Report* has been released annually since 2014. It is a product of collaborative work of the Market Early Warning Expert Committee and the Department of Market and Informatization of MARA as well as the Agricultural Information Institute of CAAS and other relevant agricultural institutes in China. The *2023-2032 China Agricultural Outlook Report*, based on macroeconomic, demographic, currency exchange rate, and oil price information, offers projections for the agricultural sector in China. The research team who simulated these projections used the CAMES (China Agricultural Monitoring and Early Warning System) model. CAMES uses data from Chinese ministries in charge of natural resources, agriculture and rural affairs, water, and commerce; the Chinese customs authorities, the National Bureau of Statistics, the National Weather Bureau, CAS (Chinese Academy of Sciences), CAAS, as well international sources like FAO, OECD, IMF, World Bank, IFPRI, USDA, and G20-AMIS to provide one overall and 11 sectoral projections for the agriculture sector as shown in figure 1.

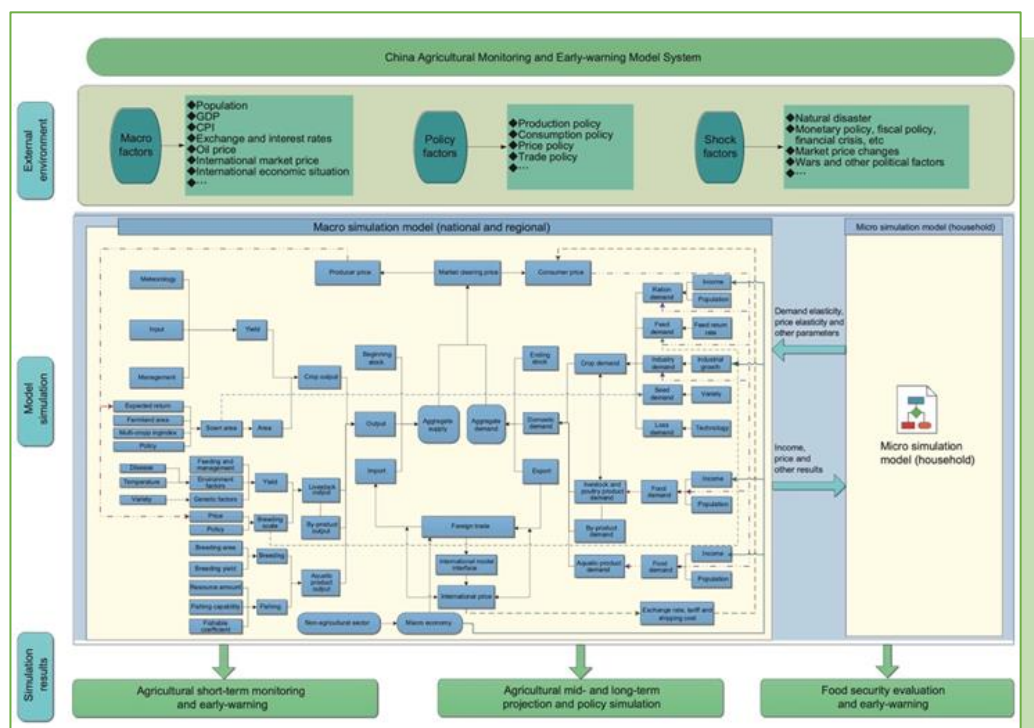


Figure 1: Structure of the China Agricultural Monitoring & Early Warning Model System CAMES (Xu et al., 2015)

3. Macro trends

3.1 Macroeconomics

The CAMES model predicts that Chinese GDP growth will be at 5% in 2023 and that long-term average annual GDP growth from 2023 to 2032 will stay around 4.9%. This is much more optimistic and stable than many other organization's projection. For instance, the International Monetary Fund (IMF) projects that Chinese GDP growth will drop to 4% by 2025 (IMF, 2023). China's shrinking and aging population, stagnant productivity, an indebted real-estate sector, burgeoning government deficits, and ongoing geo-political tensions with major trading partners might make these positive projections increasingly untenable.

3.2 Demographics and urbanization

In 2022, China had 1.411 billion people and reported its first population decline of 850,000 (Davidson, 2023), which officially marked the peak and declining of the Chinese population. UN estimates confirmed that India surpassed China to become the world's most populous country in April of 2023 (UN, 2023). With the total fertility rate of 1.2 for per woman, which is one of the lowest in the world, the Chinese population could be halved by the end of the 21st century, according to the pessimistic scenario range by the UN. However, the *Outlook* projects that the Chinese population will decrease only slightly by 1.4% in 2022 to 1.391 billion people by 2032.

According to the *Outlook*, the Chinese urbanization rate and population with registered urban residency stood at 65.2% and 48% in 2022, respectively. The gap in urbanization rate and registered urban residents is rooted in the archaic Chinese residential registration system that classifies residents by their birth place or ancestral lineage, making it hard to change the residence status even when people relocate to cities later in life. The *Outlook* projects that China's urbanization rate and population with registered urban residency will increase to 71.8% and 56.2% by 2032, respectively, pointing to an easing in the residential registration system in some places

3.3 Residents' income and consumer price index

According to the *Outlook*, per capita disposable income for stood at 36,883 RMB in 2022, which marks an increase by 5% from the previous year. However, huge disparity exists between urban and rural residents in terms of per capita disposable income. While in 2022 urban residents had an average annual income of 49,283 RMB, rural residents only had 20,133 RMB at their disposal. The *Outlook* predicts that China's rural revitalization and poverty alleviation efforts along with relaxations in the *hukou* (residential registration) system will close this gap. According to the *Outlook*, per capita disposable income for average Chinese will reach 68,824 RMB in 2032, with 74,259 RMB for urban residents and 37,254 RMB for rural residents (according to 2022 as basis, excluding price factors).

The consumer price index (CPI) in China stood at 2% in 2022, below the 3% target inflation rate by People's Bank of China. It is quite a contrast to the most advanced economies, which have been suffering from extremely high inflation due to their loose monetary and spending policies aimed at tackling the Covid-19 pandemic and due to supply chain shocks resulting from the ongoing war in Ukraine. The *Outlook* projects that the CPI will stay below 3% during the 2023-2032 period. However, geopolitical tensions, the increasing bifurcation of global trade and

technology, and ongoing volatility in commodity and currency markets will pose great challenges to keep inflation in check.

3.4 Oil price

The pandemic-induced supply chain disruptions and the shock resulting from the Russia-Ukraine conflict saw a spike in oil prices over 100 USD per barrel in 2022, although prices declined and stabilized in early 2023. However, oil prices remain volatile, with the World Bank estimating that oil prices will stay between 60 and 90 USD per barrel range in 2023. The *Outlook* agrees with this assessment and cautions more volatility could be expected in oil prices due to increasing geopolitical instability in major oil producing regions. Oil and other fossil fuels are still major energy production sources for the agricultural sector in China. The diversification of import sources and developing more domestic renewable energy sources could alleviate the situation and maintain sustainable production levels in agriculture.

3.5 Renminbi exchange rate

As the largest agri-food importer, China is susceptible to exchange fluctuations of the major foreign currencies widely used in international trade, with the USD being chief among them. The US Federal Reserve's aggressive interest rate hikes in 2022 and 2023 to curb the wide-spread inflation in the US led to a dramatic depreciation of the RMB against the USD, making agricultural imports more expensive. Since then, the USD declined from its highest valuation of 7.25 RMB in 2022 to 7.1 in June of 2023, but volatility still remains. The *Outlook* predicts that the exchange rate will stay between 6.4 and 6.6 RMB/USD in 2023-2032. To reduce risks on overreliance on the USD for international trade, China has taken some steps to diversify currency exchanges through bilateral agreements with Russia and other countries that will enable them to settle their bilateral trade in their own currencies.

4. Overall agriculture projections

The *Outlook* states that the population employed in agriculture stood at 170.7 million in 2022, marking a decrease of 0.7% from the previous year. This still consisted of 22.9% of the overall labor force. In contrast to the advanced economies, which have a very small but very productive agricultural labor force, the Chinese agricultural labor force has more potential for further decrease in both absolute numbers and percentage.

With arable land resources of 128 million hectare in 2022 – higher than China's self-imposed redline of 120-million-hectare – China will focus its efforts on constructing or improving high-quality farmland. The *Outlook* projects that the permanent high-quality farmland area will reach 100 million hectares by 2032.

The *Outlook* projects that national annual water use will be controlled at 640 billion m³, and efforts will be made in water conservation and water use efficiency.

Currently, the technology contribution of the agriculture sector in China stands at 62.4%. The *Outlook* projects that it will reach more than 68% in 2032 and that the agricultural mechanization rate will reach more than 80% in the same period.

5. Grain

5.1 Current situation 2022

The total cropland area in China stood at 118 million hectares and per hectare production reached 5805 kg, decreasing slightly from the previous year. The annual grain harvest amounted to 687 million tons in which summer, fall, and early rice harvest reached 147, 511, and 28.1 million tons, respectively. Annual food grain production reached 633 million tons, of which 209, 138, and 277 million tons accounted for rice, wheat, and corn, respectively. Oil seed production reached 23.5 million tons, marking an increase of 19.6%, and soy bean production increased to 20.2 million tons, expanding significantly across the country.

Total grain consumption stood at 798 million tons, a decline of 2.9%, with human food grain consumption at 299 million tons and animal feed grain consumption at 230 million tons, among which 91.8 million tons of soybean were consumed and overall industrial grain consumption was 127 million tons.

Grain prices increased by 27% in 2022, leading to a decrease in import and export by weight, which was 147 million tons for import and 4.3 million tons for export. However, both export and import increased by value due to inflation and dramatic price increases resulting from war in Ukraine. The average grain price in China was 2.79 RMB/kg, marking an overall increase of 4.6%. Amongst the major grains, wheat prices rose to 2.83 RMB/kg, marking a 12.8% increase, corn rose to 2.55 RMB/kg, marking a 4.3% increase, and soybean rose to 6.18 RMB/kg, marking an 8.7% increase. By contrast, rice dropped to 2.74 RMB/kg, a decrease of 2.2%. The CAMES model price prediction was in line with data collected from the real market.

5.2 Future projections

5.2.1. Production

The Outlook model projects that the planted grain area in China will reach 119, 120, and 121 million hectares by 2023, 2027, and 2032, respectively – an overall increase of 2.8%. It predicts that the aggressive campaign to prevent “non-agriculturization” of farmland, further protections of black soil, intensification of high-quality farmland construction, expansion of grain planting into the southern regions, and mixed corn-soybean planting will help to achieve these increases in cropland area. The CAMES model predicts that grain production in China will reach 694, 729, and 767 million tons by 2023, 2027, and 2032, respectively, which would imply an annual output increase of 1.1% and an overall increase of 12.8%. Overall grain projections are shown in figure 2 below.

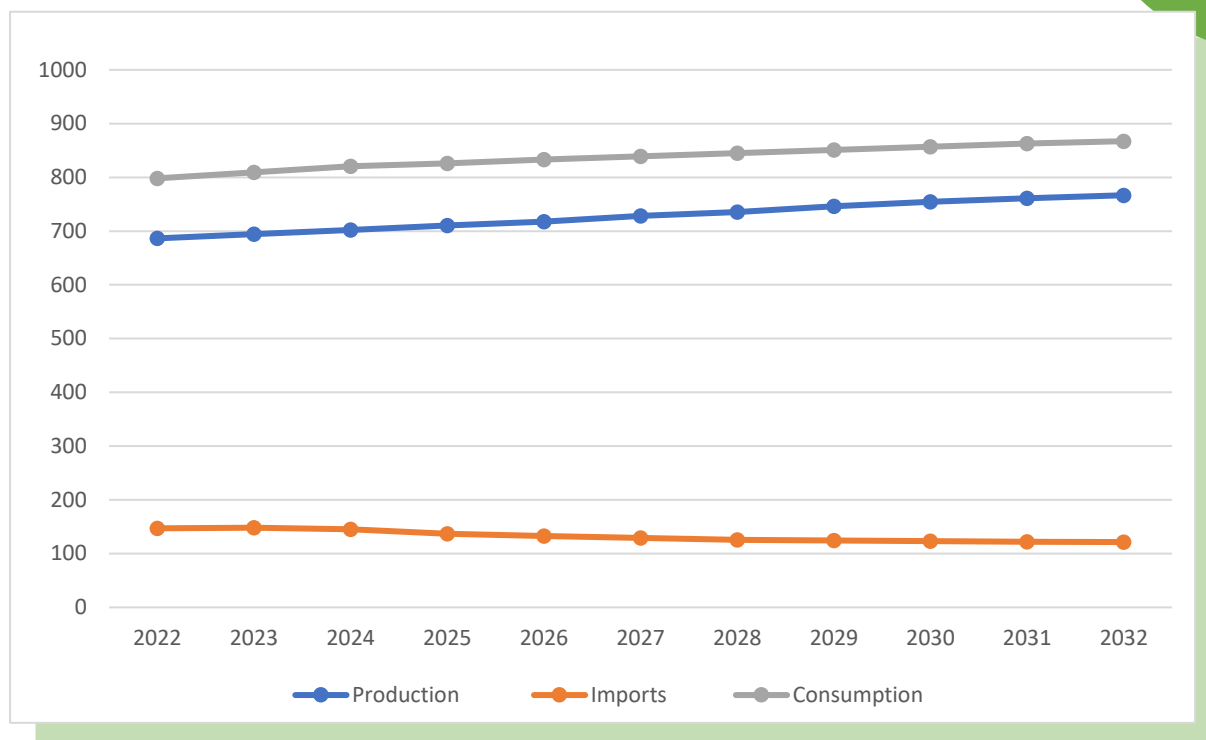


Figure 2: Overall grain projection for China 2023-2032 in million tons (MARA, 2023)

The CAMES model projects that grain productivity per hectare will reach 5,850, 6,075, and 6,345 kg by 2023, 2027, and 2032, respectively, which would imply an annual increase of 0.9% and an overall increase of 9.8%. The further land consolidation, mechanization and digitalization, better seeds and advanced irrigation, fertilizer, and farmland management are listed as key factors to make these improvements.

5.2.2 Consumption

The CAMES model projects that overall grain consumption will reach 810, 839, and 867 million tons by 2023, 2027, and 2032, respectively, which would indicate an annual increase of 0.6% and an overall increase of 6.5%. It also projects that human grain consumption will reach 302 million tons in 2023 and then decline to 301 and 299 million tons by 2027 and 2032, respectively – an overall decrease of 1.1%. The decline in grain consumption will be driven by slight changes in diet patterns and a decrease in the overall population, according to the model.

Animal feed grain consumption will reach 234, 250, and 269 million tons by 2023, 2027, and 2032, respectively – an overall increase of 4%. With the growing affluence of Chinese consumers, more will turn to animal protein-based diets, which demands an increase in feed grain production. Total industrial grain consumption will reach 128, 139, and 153 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 20.4%. The increasing use of grains in alcohol, grain-based condiments such as vinegar and soy sauce, as well as drug production will be drivers of this increase.

5.2.3 Trade

Overall grain trade will decrease during the 2023-2032 period. The grain import of China will reach 148 million tons, marking an increase of 1% in 2023, and then decline to 129 and 122 million tons by 2027 and 2032, respectively – an overall decrease of 19.7%. This projection has profound

implications for global grain trade and major grain exporting nations like Brazil, the US, and Australia. The *Outlook* report also outlines that import diversification and resilience of the grain supply chain will be a priority. In contrast to imports, Chinese grain exports would reach 4.6, 5.23, and 5.76 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 30.5%. Growing rice exports will be the main driver of this increase. However, Chinese grain exports would be still far smaller and less significant compared to its grain imports and, thus, would have less impact on global grain markets.

5.2.4 Price

The CAMES model projects that the overall grain price index will stay around 109. However, it cautions that an increase in labor and production costs, increasing climate change-induced weather disasters, increased use of biofuels, fossil fuel price volatility, the instability in currency markets, and heightened geo-political tensions could bring more uncertainties to the price stability of grains.

6. Grain projections by crops

6.1 Rice

6.1.1 Current situation

As the most favored grain in the Chinese diet, rice production will be a top priority for China. In 2022, rice production declined to 208.5 million tons, an annual decrease of 2%, and the rice planted area also declined to 29.4 million hectares, decreasing by 1.6% per year. Per hectare productivity also declined to 7,080 kg, marking a 0.5 % annual decrease. This was due to production disruptions resulting from strict Covid-19 restrictions and a prolonged drought in 2022 in the major rice producing regions in central and southern China. National rice consumption declined to 212 million tons, in which human, feed, and industrial consumption stood at 156.8, 25.7, and 16.7 million tons, respectively, marking a decrease in all three categories. Rice imports reached 8.85 million tons, an increase of 24.5%, exceeding the annual import quota levels. On the other hand, rice exports declined to 3.19 million tons, a decrease of 9.5%. India, Pakistan, Vietnam, Thailand, and Myanmar were the top five rice import sources for China.

6.1.2 Future projections

The *Outlook* projects that the planted rice area in China will stay at 29.8, 28.5, and 27.6 million hectares by 2023, 2027, and 2032, respectively, marking an overall decrease of 4.1%. The report further predicts that rice production in China will reach 210.2, 210.4, and 209.8 million tons by 2023, 2027, and 2032, respectively, implying an overall decrease of 0.4%. The *Outlook* projects that rice productivity per hectare will reach 7,180 kg, 7,361 kg, and 7,594 kg by 2023, 2027, and 2032, respectively, which would imply an annual increase of 0.7% and an overall increase of 7.3%.

The *Outlook* projects that overall rice consumption will be at 214.2, 216.1, and 210.7 million tons by 2023, 2027, and 2032, respectively – an overall decrease of 1.9%. It also projects that human rice consumption will decline to 155.7, 151.3, and 145 million tons by 2023, 2027, and 2032, respectively, implying an overall decrease of 8.2%. The aging population and dietary diversification will be the main reasons for the decline in human rice consumption. Animal feed rice

consumption will reach 27.2, 32, and 35.8 million tons by 2023, 2027, and 2032, respectively. Total industrial rice consumption will reach 16.8, 17.5, and 18.9 million tons by 2023, 2027, and 2032, marking an overall increase of 13.5%.

The *Outlook* projects that the rice imports of China will decline to 8, 7.6, and 7.2 million tons by 2023, 2027, and 2032, respectively, suggesting an overall decrease of 7%. On the other hand, Chinese rice exports will reach 3.5, 3.9, and 4.1 million tons by 2023, 2027, and 2032, respectively - an overall increase of 24%. Domestic Chinese rice prices will stay around 2.7-2.9 RMB/kg.

The *Outlook* lists the impact of increasing numbers of climate change-induced weather disasters on rice producing regions, a growing focus on domestic soy bean production and expansion, and an alarming trade protectionism and export bans in some countries as major uncertainties to the rice sector in China.

6.2 Wheat

6.2.1 Current situation

As the largest wheat producing nation in 2022, Chinese wheat production increased to 137.7 million tons, an annual increase of 0.6%, while the wheat planted area stayed stable at 23.5 million hectares. Per hectare productivity also increased to 5,850 kg, marking an annual increase of 0.8%. National wheat consumption declined to 131.9 million tons, in which human, feed, and industrial consumption stood at 91.2, 17, and 12.2 million tons, respectively, marking a decrease in human and animal feed consumptions. Due to an increase in the use of better seeds, seed consumption declined to 5.8 million tons – a decrease of 3.5%.

In 2022, wheat imports reached 9.9 million tons - an increase of 1.9%, exceeding annual import quota levels. Wheat exports also increased to 0.15 million tons, marking an 82% increase. Australia, Canada, and France were the top three wheat import sources for China.

6.2.2 Future projections

The *Outlook* projects that the planted wheat area in China will stay stable at 23.5, 23.4, and 23.4 million hectares by 2023, 2027, and 2032, respectively. The report further projects that wheat production will be at 138.5, 141.5, and 143.9 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 5.6%. Wheat productivity per hectare will reach 5,895 kg, 6,045 kg, and 6,150 kg by 2023, 2027, and 2032, respectively, implying an annual increase of 0.6% and an overall increase of 6.1%.

The *Outlook* projects that overall wheat consumption will be at 132.8, 136.2, and 141.3 million tons by 2023, 2027, and 2032, respectively. It also projects that human wheat consumption will reach 91.9, 92.6, and 93.2 million tons by 2023, 2027, and 2032 – an overall increase of 2.1%. Animal feed wheat consumption will stay stable at 16.8, 16.5, and 16.3 million tons in 2023, 2027, and 2032, respectively. Total industrial wheat consumption will reach 12.4, 15.5, and 20.4 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 69% and with alcohol and processed starch production stimulating increases in the industrial usage of wheat. Seed consumption for wheat will stay stable at 5.8, 5.8, and 5.7 million tons in 2023, 2027, and 2032, respectively, marking an overall decrease of 3.4%.

The *Outlook* projects that wheat imports will decline from 10 million tons in 2023 to 7.6 and 6 million tons by 2027 and 2032, respectively, marking an overall decrease of 35%. The report lists the impact of an increasing number of climate change-induced weather disasters on wheat producing regions and price fluctuations in global markets due to geopolitical tensions such as the Russia-Ukraine conflict as major uncertainties to the wheat sector in China.

6.3 Corn

6.3.1 Current situation

Since 2011, corn has been the largest grain by production in China. In 2022, corn production increased to 277.2 million tons, marking an annual increase of 1.7%. The corn planted area also stayed stable at 43 million hectares and per hectare productivity increased to 6,435 kg, marking an annual increase of 2.3%. National corn consumption increased to 287.5 million tons, in which human, feed and industrial consumption stood at 9.8, 185, and 81 million tons, respectively, marking a slight increase in all three categories. Due to the increasing use of better seeds, seed consumption declined to 2 million tons. In addition to increases in domestic corn production, China also ramped up its corn imports. In 2022, corn imports reached 20.6 million tons, an increase of 27.3%, and the per ton import price stood at 344 USD. The US and Brazil were the top two corn import sources for China, while Ukraine ranked third, despite the ongoing Ukraine-Russia conflict.

6.3.2 Future projections

The *Outlook* projects that the planted corn area will increase to 43.2, 43.9, and 49.3 million hectares by 2023, 2027, and 2032, respectively. Corn production will increase to 280.8, 303.5, and 238.7 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 21.7% as shown in figure 3. According to the report, corn productivity per hectare will reach 6,495 kg, 6,915 kg, and 7,484 kg by 2023, 2027, and 2032, respectively, implying an annual increase of 0.6% and an overall increase of 17.8%.

The *Outlook* projects that overall corn consumption will increase from 291.7 million tons in 2023 to 309.1 and 332.5 million tons by 2027 and 2032, respectively, marking an overall increase of 16%. It also projects that human corn consumption will increase from 9.9 million tons in 2023 to 10.6 and 11.5 million tons by 2027 and 2032, respectively. Animal feed corn consumption will reach 187.8, 199.3, and 214.7 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 16%. Total industrial corn consumption will reach 82.4, 87.8, and 95.3 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 18% that will mostly be stimulated by an increase in alcohol production.. Seed consumption for corn will stay stable at 2 and 2.5 million tons in 2027 and 2032, respectively.

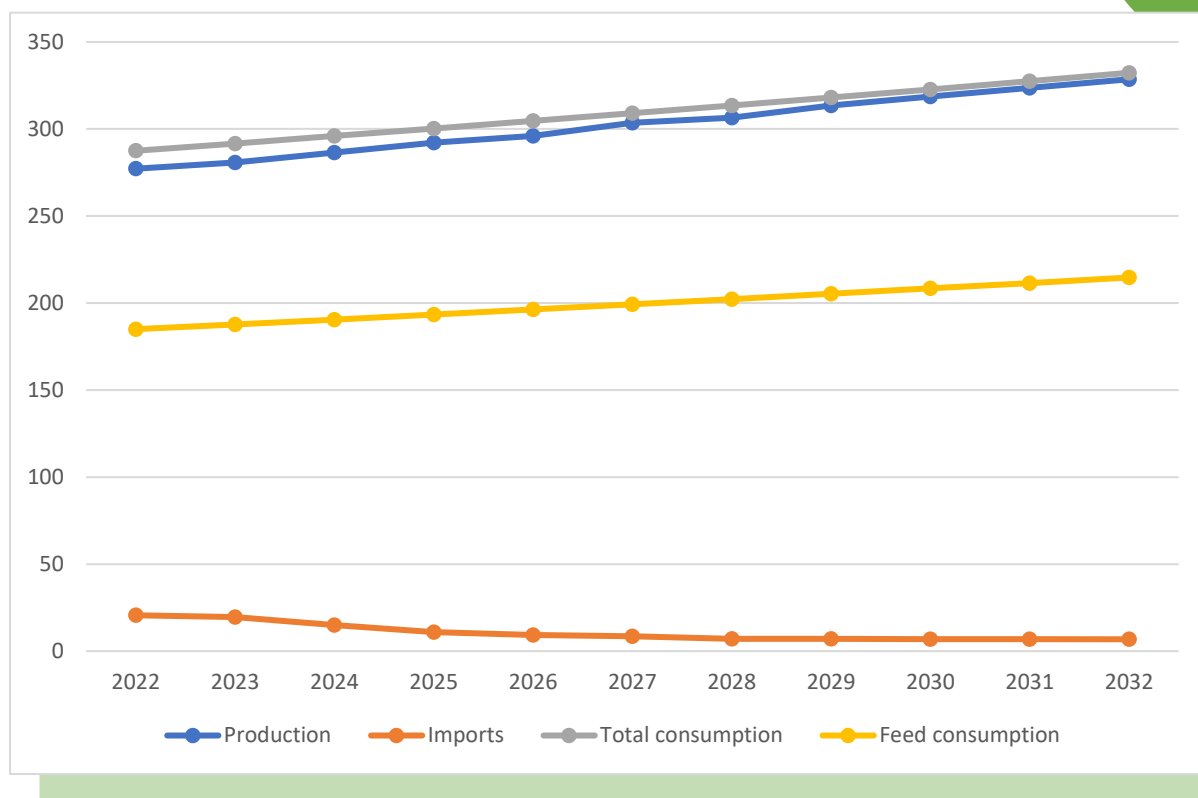


Figure 3: Corn projections for China 2023-2032 in million tons (MARA, 2023)

The *Outlook* projects that corn imports will decrease to 19.5, 8.5, and 6.8 million tons by 2023, 2027, and 2032, respectively, marking an overall decrease of 65 %. Brazil, US, and the Ukraine will remain top corn import sources for China. The *Outlook* lists the impact of an increasing numbers of climate change-induced weather disasters on corn producing regions and price fluctuation in global markets due to geopolitical tensions such as the Russia-Ukraine conflict as major uncertainties to the corn sector in China.

6.4 Soybeans

6.4.1 Current situation

Soybeans are the Achilles' heel of China's food security, with the country relying on imports for around 80% of its domestic demand, which is mostly driven by animal feed consumption. To reduce dependence on soybean imports, the government has introduced measures such as corn-soybean intercropping that are hoped to expand domestic soybean production without reducing output of other crops. In 2022, soybean production stood at 20.3 million tons and the soybean planted area at 10.2 million hectares. Per hectare productivity also increased to 1,980 kg. National soybean consumption declined to 108.5 million tons, in which human, feed, and industrial consumption stood at 13, 92, and 3 million tons, respectively. While there has been an increase in all three categories, animal feed consumption continues to massively outstrip human and industrial consumption.

Soybean imports decreased from their historic high of 100 million tons in 2020 to 91 million tons in 2022, marking a decrease of 5.6%. The import price per ton stood at 344 USD. The US, Brazil, Argentina, Canada, and Russia were the top five soybean import sources for China.

6.4.2 Future projections

The *Outlook* projects that the planted soybean area will increase to 10.6, 11.7, and 13.4 million hectares by 2023, 2027, and 2032, respectively. Soybean production is projected to increase to 21.7, 27.9, and 36.7 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 95% as shown in figure 4. The report projects that soybean productivity per hectare will reach 2,055 kg, 2,385 kg, and 2,745 kg by 2023, 2027, and 2032, respectively, which would imply an annual increase of 3.4% and an overall increase of 39%. Despite these impressive gains, domestic production will still remain well below projected consumption levels.

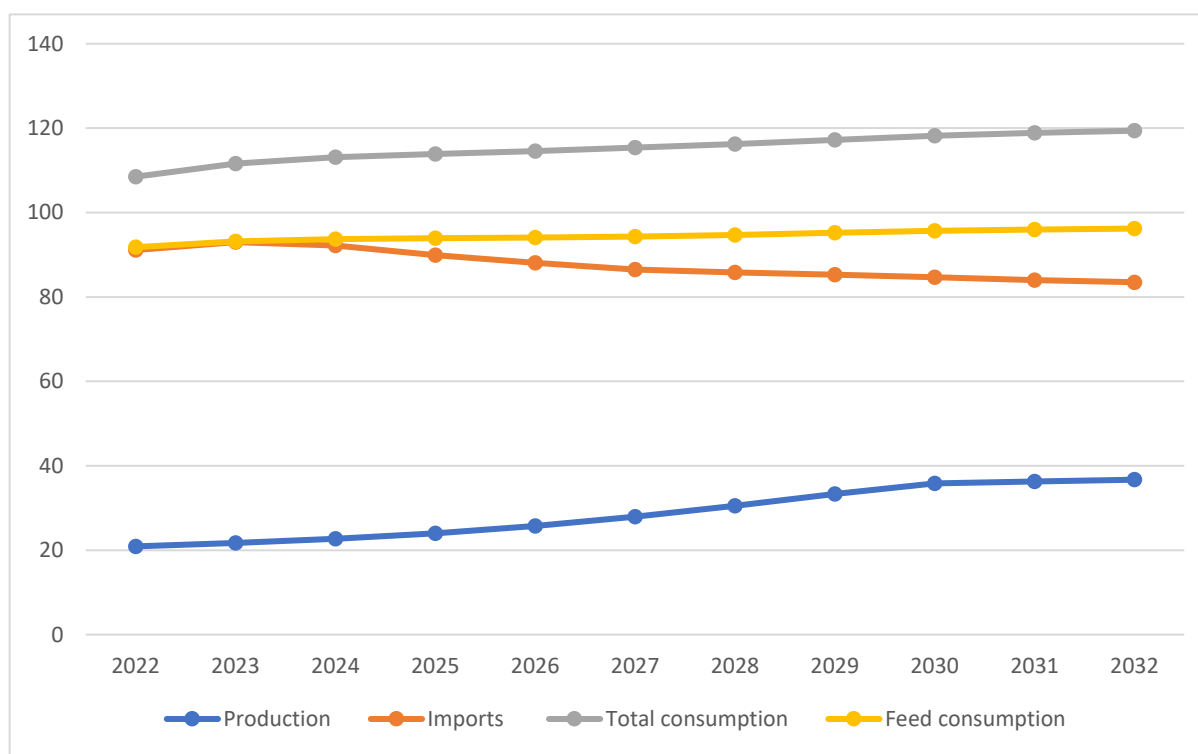


Figure 4: Soybean projections for China 2023-2032 in million tons (MARA, 2023)

The *Outlook* projects that overall soybean consumption will increase to 111.6, 115.4, and 119.4 million tons by 2023, 2027, and 2032, respectively, marking an overall increase of 6%. Human soybean consumption is projected to increase to 14.2, 16.4, and 18.1 million tons by 2023, 2027, and 2032, respectively. Animal feed soybean consumption will reach 93.3, 94.3, and 96.2 million tons by 2023, 2027, and 2032, respectively.

Soybean imports are projected to decline from 93 million tons in 2023 to 86.5 and 83.5 million tons by 2027 and 2032, respectively, marking an overall decrease of 13%. Soybean will remain the largest grain import in this period, with Brazil and the US remaining China's top soybean import sources. The *Outlook* lists the impact of an increasing numbers of climate change-induced weather disasters on soybean producing regions and domestic agricultural support policy, price fluctuation in global markets due to geopolitical tensions and disruptive monetary policy in some countries, and the growing use of soybeans as biofuels in major soybean producing nations like the US and Brazil as major uncertainties to the soybean sector in China.

7. Meat, poultry and dairy sector

7.1 Meat and poultry

7.1.1 Current situation of the meat and poultry sector

In 2022, meat production stood at 93.4 million tons, marking an increase 3.9% compared to the previous year. National meat consumption stood at 98.7 million tons – an increase of 1.6% from the previous year – and per capita annual meat consumption stood at 70kg. Meat imports declined to 6.13 million tons, decreasing by 22.8%. This might reflect the pork sector recovery from the 2018-2020 African Swine Fever outbreak.

In 2022, China produced 699.9 million live pigs -an increase of 28.6 million. It also produced 48.4 million live cows, marking an increase of 1.32 million heads and, 336 million live sheep, an increase of 5.8 million. China also produced 16.1 billion live birds, marking an increase of 400 million.

In 2022, pork production reached 55.4 million tons, an increase of 72% and poultry production reached 24.4 million tons, also marking an increase of 72%. Meanwhile, beef and mutton production remained stable at 7.2 and 5.2 million tons, respectively.

National pork consumption stood at 57 million tons, marking an increase of 0.8%; national poultry consumption stood at 25.1 million tons, an increase of 1.5%; national mutton consumption stood at 5.6 million tons, an increase of 1.1%; and beef consumption stood at 9.8 million tons, an increase of 5.8%.

Pork imports declined to 1.75 million tons, down 52%, which was the lowest import level since 2019. Main import sources were Spain, Brazil, the US, Denmark, Canada, and the Netherlands. Poultry imports stood at 1.3 million tons in 2022 and Brazil, US, Russia, and Thailand were main import sources. Beef imports increased by 14% to 2.6 million tons, with Brazil, Argentina, New Zealand, Australia, and the US as main import sources. Pork, beef, and poultry were top three meat import categories for China.

7.1.2 Future projections for the meat and poultry sector

The *Outlook* projects that total meat production in China will increase to 94.4, 97.4, and 99.9 million tons by 2023, 2027, and 2032, respectively. Meat consumption is equally expected to increase, reaching 100, 103, and 105 million tons by 2023, 2027, and 2032, respectively, as shown in figure 5. There will be 452 million live pigs, 102 million live cows, and 326 million live sheep in 2023.

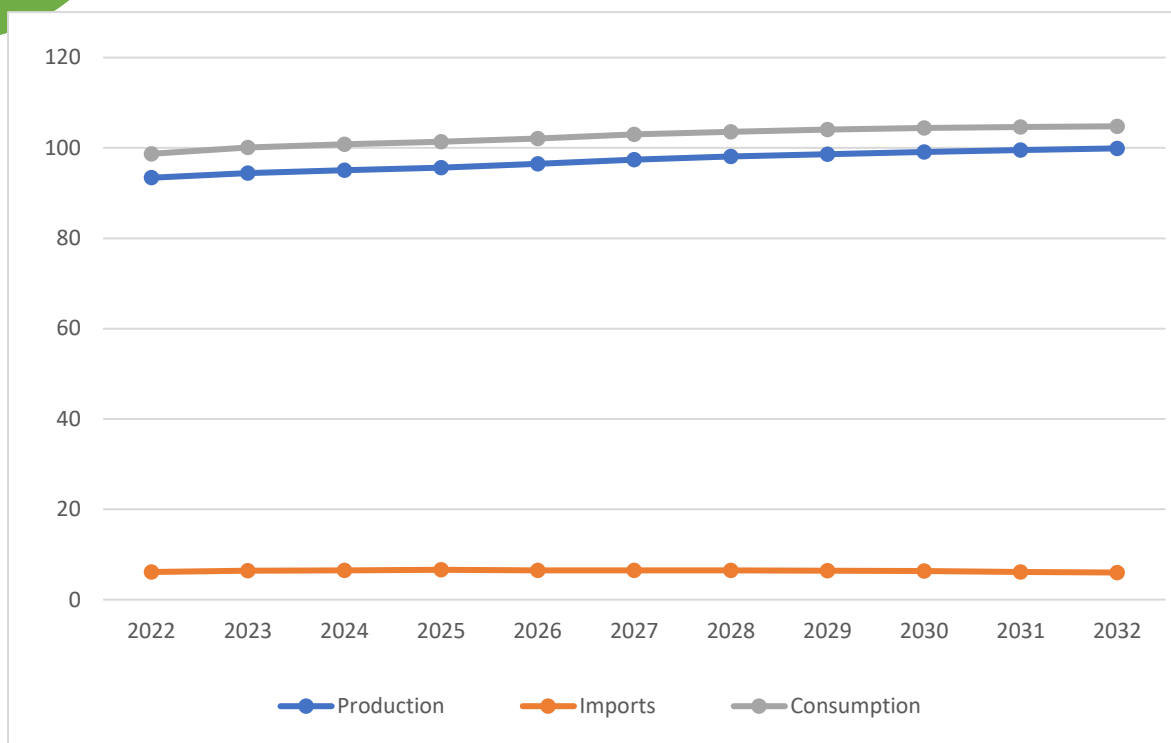


Figure 5: Meat sector projections for China 2023-2032 in million tons (MARA, 2023)

National pork consumption is projected to decrease slightly from 57.6 million tons in 2023 to 57.5 and 57.1 million tons by 2027 and 2032, respectively. National beef consumption will slightly increase to 10, 10.5, and 11 million tons by 2023, 2027, and 2032, respectively. National poultry consumption is also projected to increase slightly from 25.6 million tons in 2023 to 27.8 and 29.4 million tons by 2027 and 2032. National mutton consumption will slightly increase to 5.7, 6, and 6.2 million tons by 2023, 2027, and 2032, respectively.

Total meat imports are projected to stand at 6.45, 6.5, and 6 million tons in 2023, 2027, and 2032, respectively, marking a decrease of 19%. Pork imports will decrease to 2.1, 1.8, and 1.3 million tons by 2023, 2027, and 2032, respectively, making it the meat category with the steepest import decline. The continued recovery of the pork sector from ASF, changing diet patterns, and a shrinking population will drive this decline. Poultry imports will decrease to 1.3, 1.2, and 1.1 million tons by 2023, 2027, and 2032, respectively. In contrast, beef imports are projected to increase to 2.7, 3, and 3.1 million tons by 2023, 2027, and 2032, respectively.

The *Outlook* lists the impact of an increasing number of climate change-induced weather disasters and the spread of animal-borne infectious diseases, price fluctuations in the feed grains, environmental impacts of animal farming, and trade tensions as major uncertainties to the meat sector in China.

7.2 Dairy sector

7.2.1 Current situation of the dairy sector

In 2022, Chinese dairy production stood at 40.2 million tons, an increase of 6.5% over the previous year. National dairy consumption stood at 58.7 million tons, marking an increase of 1.7% compared to the previous year, and per capita dairy consumption stood at 41.5 kg per annum.

Dairy imports declined to 3.2 million tons, a 17% decrease. The main reason for decline was price inflation of dairy products globally, especially in dairy exporting countries. Main import sources were New Zealand, the EU, the US, and Australia.

7.2.2 Future projection for the dairy sector

The *Outlook* projects that total dairy production will increase to 42.2, 49.4, and 56 million tons by 2023, 2027, and 2032, respectively. Total dairy consumption will increase to 61, 70, and 79 million tons by 2023, 2027, and 2032, respectively. Total dairy imports are projected to reach 18.8, 21, and 23.2 million tons by 2023, 2027, and 2032, respectively, marking a substantial increase. Dietary changes of an increasingly health-conscious middle class will drive these increases.

The *Outlook* lists inferior technology of the Chinese dairy sector, the impact of an increasing number of climate change-induced weather disasters, and uncertainties in regulatory and trade rules such as carbon emission tax proposals in some countries or restrictions on live animal trading as major uncertainties to the dairy sector in China.

8. Overall assessment of the *Outlook* report

Methods: Although the CAMES model claims to be a broad-based and integrated model, the details and exact data sources, parameters, and methods have not been transparently shared. How CAMES weighs different datasets against each other would be critical to assess its reliability and accuracy. Predictions from the model have also been proven wrong in the past. For example, the 2016 China Agricultural Outlook report predicted that the Chinese population would still grow until 2025 – a projection that turned out to be incorrect.

Reliability and transparency of the data: The general mismatch between the dire food security rhetoric and optimistic projections of forever-increasing production numbers despite weather events and external challenges have raised some skepticism about the reliability of the data. For example, May & Zhang suggested that the official grain numbers might be overestimated or inflated (May & Zhang, 2023).

Projections in the *Outlook* report might well turn out to be overly optimistic. The aging and shrinking population, increasing debt burdens in real estate and state-owned companies, and geopolitical instability will make it hard to keep annual GDP growth above 4.6 % in the next ten years. The UN and World Bank (World Bank, 2023) also predict that the Chinese population decline will steadily accelerate unless there are drastic improvements in the social welfare system such as more support for child rearing and a relaxation of immigration policies.

Projections in other outlooks: The OECD-FAO Agricultural Outlook 2022-2031 also predicts that China's agricultural production will increase by 20% by 2031, however pork output in 2031 would be only 5% higher than the 2018 pre-ASF level (OECD-FAO, 2022), which is less optimistic than

the CAMES model. In contrast to CAMES, it predicts that Chinese soybean imports will still grow at 16% by 2031. Recent USDA projections also predict that Chinese pork production will only slightly exceed pre-ASF levels by 2032, which is in line with OECD predictions (USDA, 2023). Like OECD-FAO, USDA also predicts that China's soybean imports will grow 3% annually, reaching 134 million tons by 2032, which contradicts CAMES model's decline in soybean imports for China. International projections show higher levels of agri-food imports to China than CAMES predictions. This discrepancy needs further scrutiny by agricultural trade and policy watchers.

Uncertainties to these projections: Although *Outlook* is more optimistic about the contribution of technology in improvement of food production, the impact of climate change-induced weather events and environmental degradations like soil and water pollution on the food production should be assessed carefully and factored strongly into the projections.

Aging and rural demographic decline might hinder the progress in agricultural efficiency efforts, which should be sufficiently included in the CAMES model.

Although the *Outlook* report mentions climate change as factor in their projections, the exact contribution of climate change on future agri-food production is not quantified. This would cloud the optimistic scenarios laid out in the CAMES projections. Other studies carried out by scientists from Peking University using the CAPSiM model have shown that rice, wheat, corn, and oil seeds production would decline by 2030 under the RCP 2.6 and RCP 8.5 climate scenarios (Cui et al., 2022).

9. Implications of the *Outlook* report

1. If the Outlook projections are correct, they will have profound implications for **global agricultural trade** and China's **natural environment**. In terms of trade, if the measures to achieve domestically driven grain security are successful and Chinese imports of vital grain crops decrease as predicted, this might force international suppliers to find alternative costumers. In terms of the environment, efforts to achieve self-sufficiency in grains might compromise the environmental protection and climate mitigation goals. Some domestic commentators have already second guessed the negative consequences of successful afforestation projects in the 1990s and early 2000s on Chinese food security (Wang et al., 2023). Heavy use of chemical inputs to increase production would further degrade already polluted soil and water resources, thereby further undermining the long-term sustainability of China's agri-food system.
2. More widespread application of **technology in food production** through mechanization and the use of digital and bio-tech, as suggested in the *Outlook*, would provide enormous opportunities for domestic and foreign companies who develop these products and services. However, the insufficient infrastructure, low digital literacy among rural elderly, and data security concerns still remain as major hurdles to these efforts. The increased use of biotech such as enhanced seeds, GMO, and gene editing would provide opportunities for innovation and international cooperation in the sector, but it would also bring biosecurity risks and ethical challenges.
3. Increasing food production will also have **social impacts** on rural communities. Balancing the competing and conflicting priorities among food production, rural revitalization, and urbanization is a tough task which requires careful handling by policy makers.

4. The **changing dietary preferences** of Chinese consumers from carbohydrate-based diets to protein-based diets will increase demand for feed grains and animal meat production as well as accelerate innovations in alternative proteins. Increases in animal meat and feed production from growing demand for animal protein will further strain domestic natural resources like water, soil, and grasslands and raises animal welfare questions. Potential increases in dairy consumption will provide opportunities for both domestic and international producers.
5. The full impact of **climate change** in agri-food production is yet to be determined. However, the CAMES model likely underestimates the volatility climate change will bring to the agri-food sector.

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