CHINA AGRICULTURE

Addressing China food security – revolution of tradition

As food supply faces increasing challenges due to cyclical and disruptive factors, and structurally heightened risks from climate change, we view agriculture efficiency as an essential part of the long-term solution for food security. And for China, much can be done in revolutionizing the efficiency as smarter agriculture thrives and changes how grains and animal proteins are produced, for a more self-sufficient and resilient outlook. We map growth opportunities in modern seed breeding, animal health management, advanced feed additives, and precision farming practices that could ultimately drive the reduction of China’s import reliance of major agriculture products by more than 80% from the potentially 90mn hectares in arable land equivalent.

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As food supply faces increasing challenges due to cyclical and disruptive factors, and structurally heightened risks from climate change, we view agriculture efficiency as an essential part of the long-term solution for food security. And for China, much can be done in revolutionizing the efficiency as smarter agriculture thrives and changes how grains and animal proteins are produced, for a more self-sufficient and resilient outlook.

With 9% of the global arable land and 18% of the global population, China has managed to feed a population of 1.4bn mostly on domestic agriculture production. Yet, the intrinsic challenges on food security persist – China’s import of major agriculture products, including grains and animal proteins, has been structurally moving up in the past 30 years. Translating the imports in terms of arable land equivalent, we estimate it has reached 71mn ha today, equivalent to nearly 68% of China’s total arable land – a number that has been moving up by nearly 30% every 10 years since 2000, and could reach nearly 90mn ha or 90% in the next 10 years, by our estimates, as growing demand meets inelastic supply in this most traditional sector.

The long-term challenges for China agriculture supply are limitation of land and low efficiency. Arable land has been most stagnant in the past three decades, mostly in line with global trends. Yet, corn output per hectare in China is 40% less than in the US, and it takes 6%-26% more grains to produce 1 kg of pork or chicken. Grain production cost in China was in line with the US and Brazil in 2007, but is now twice as high, as a result of low yield, high use of pesticides and herbicides, the shrinking rural work force, and rising land costs. Climate change has also had a profound impact on agriculture resources in China. According to China’s Ministry of Agriculture (MOA), the nation’s average precipitation has been rising each year, with a northward shift of the rainfall belt, impacting winter wheat planting and leading to more unpredictable extreme weather. In addition, we estimate nearly 18% of the arable land has been affected by pests each year, and 12% by extreme weather.

However, we see China making a structural shift away from the traditional input-intensive approaches, ultimately reducing its import reliance, as adoption of modern seed breeding, animal health management, advanced feed additives, and precision farming practices rise. Specifically, we estimate improvement in seeds performance could lead to more grain output equivalent to 22.4mn ha of arable land in the coming years, while precision farming would further enhance the yield potential in the longer run, leading to 29.9mn ha equivalent of higher output. At the same time, animal health product penetration and advanced feed additives would not only drive safer food and higher supply sustainability, but also save grain consumption by an equivalent of 7mn ha of land. Combined with other factors such as improved food waste management, we estimate the potential efficiency gain would reduce China’s LT food imports by over 80% to as low as 14mn ha, reversing the trend of the past three decades. Both government policies and advanced bio-technology and tools will facilitate and expedite the changes, in our view.
We note this report does not include details about addressing demand side shifts in food basket as incomes grow, but the analysis can be found in an earlier report – Feeding China’s changing appetite. It also doesn’t seek to address risks/the sudden impact of a change in government policy beyond the current trend. Lastly, while we discuss the critical role of precision farming development in China, our report doesn’t seek to address investment opportunities in precision farming given the early stage of development, although we acknowledge the technology upgrade in China’s machinery industry as one of the key drivers.
Exhibit 1: The road to ultimate food security – potential efficiency approaches to boost China’s food supply self-sufficiency

Approaches to reduce China’s import reliance of agriculture products (in mn hectares of arable land equivalent)

- **SEEDS**
  - 1st generation GMO seeds for 10% yield improvement
  - Next generation GM seeds and germplasm to deliver 30% yield improvement

- **PRECISION FARMING**
  - Yield enhancement through precision GPS, planting, input applications, autonomous driving, and water irrigation

- **ANIMAL HEALTH ADV FEED ADDITIVES**
  - Vaccines, alternatives for antibiotics, enzyme, gut health, immunity enhancement

- **FOOD WASTE MANAGEMENT**
  - Reducing waste in logistics and food services by 50%

- **LT IMPORTS**
  - Reduced to 13.8 mn hectares equivalent

Exhibit 2: China import of major agriculture products per annum = 2000-2023E, and LT outlook and scenarios

- **LT IMPORTS**
  - Reduced to 13.8 mn hectares equivalent

- **SEEDS**
  - Next generation GM seeds and germplasm to deliver 30% yield improvement

Source: Goldman Sachs Global Investment Research

Exhibit 3: China import of major agriculture products in arable land equivalent = 2000-2023E, and LT outlook and scenarios

Source: NBS, MOA, FAO, USDA, Goldman Sachs Global Investment Research

8 August 2022
Agriculture ecosystem

The core of the agriculture sector. High-quality seeds with optimized germplasm and traits deliver higher intrinsic yield and cost savings, and adapt to consumer food tastes and nutrition requirements.

First-generation GM seeds in China could potentially bring a 10% improvement in yields for corn and 5% for soybeans, a significant reduction in herbicides and pesticides costs, including weed management, and lower mycotoxin in the grain produced.

Working with germplasm and biotech traits, precision farming drives the next phase of yield gains in agriculture food supply, reduces input, and contributes to climate change.

The early-stage practices help Chinese farmers to reduce input costs, and increase crop yield. The upgrading of irrigation technologies reduces water consumption by 1/3.

Refining breeding system

Refining feed for farming stages

Advanced feed additives address animal nutrition, improve feed efficiency for the production of animal protein, improve food safety, and contribute to carbon emission reduction.

Vaccination remains central in preventing and controlling infectious diseases in livestock.

The rise of pet ownership and higher adoption of basic healthcare services provide untapped growth opportunities.

More effective vaccines and a higher penetration rate for major livestock diseases, leveraging advanced vaccine technologies.

Basic care products in China with rising brand recognition.

<table>
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<tr>
<th>TAM - 2020/2021A</th>
<th>TAM - LT</th>
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<tr>
<td>US$11.2 bn</td>
<td>US$15.8 bn</td>
</tr>
<tr>
<td>US$0.5 bn</td>
<td>US$7.9 bn</td>
</tr>
<tr>
<td>US$500-700 bn</td>
<td>US$200 bn</td>
</tr>
<tr>
<td>US$10-20bn</td>
<td>US$8.0 bn</td>
</tr>
<tr>
<td>US$10.4 bn</td>
<td>US$12.4bn</td>
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Most attractive opportunities

Seeds prices to increase by 30-40% in the MT, Trait owners to benefit the most.

Top players as market consolidators

Advanced feed additives

FMD vaccine for the private market, ASF vaccines, vaccines for PRRS and PED

Pet vaccines to gain the highest growth at a 20% CAGR in the coming years.

Source: MOA, NBS, Bloomberg, Company data, Goldman Sachs Global Investment Research
Seeds are the core of agriculture, and provide key supports to China’s long-term food security. While bio-tech seeds are not the only driver for crop performance, the potential introduction of 1st generation bio-tech seeds in China will trigger a rapid industry restructure, and through higher seed prices, paving the way to incentivize and accelerate the development of better seeds that maximize crop yield potential and output in the long run.

We expect the first generation of GM seeds in China (most insect resistant and herbicide tolerant) to potentially bring an average improvement of 10% in yield for corn and 5% for soybean, significant reduction in both herbicide and pesticide costs including weed management, as well as lower mycotoxin in the grain produced. In the longer term, we estimate seeds can bring a potential 30%-60% improvement in Chinese corn yield from the current level, as bio-tech traits, germplasm, and precision farming work together to revolutionize the efficiency in grain production in China.

We also see the biotech development in seeds to accelerate the consolidation for the China seed industry and bring about stronger pricing power along the way. The prevailing trait advantage and economic benefit carried through seeds should enable rapid market share gains by top seed performers, and accelerate the elimination of the long tail end of the much fragmented industry supply. Nevertheless, we think the consolidation will be a lot more remarkable among the traits suppliers, while competition among the germplasm owners is likely to be more intense.

With the economic values created from seeds to farms and improved industry supply outlook, we expect 1st generation GM seeds to lead to 30%-40% of seed value appreciation, and potentially ~40%-80% in the long run, which would translate to attractive seed revenue growth for key beneficiaries including top bio-trait owners, and consolidating germplasm companies.
Exhibit 5: Corn yield change – US vs. China

Exhibit 6: Seed economics – DBN3601T for tropical corn in Southwest China

Exhibit 7: Market shares of corn GM traits – mid term, estimated based on weighted average of traits and regional approvals as of 1H22

Exhibit 8: Planting area by crops and potential GM penetration – China

Source: USDA, FAO, MDA, Goldman Sachs Global Investment Research

Source: Company data, data compiled by Goldman Sachs Global Investment Research

Source: MDA, Company data, Goldman Sachs Global Investment Research

Source: MOA, Goldman Sachs Global Investment Research
Animal health is about more efficient and safer production of animal protein.

China produced 225mmt of animal protein in 2021 A, yet with 6%-26% lower grain efficiency in feed conversion, based on a simple comparison of Chinese hog and poultry production efficiency versus other countries. Should China produce major livestocks at the same efficiency as other countries, we estimate domestic grain consumption would decline by over 60mmt, all else equal, equivalent to 5%-12% of domestic grain demand.

This gap is driven by the health of livestocks, which needs to be addressed more in China given the higher farming intensity, and more frequent disease outbreaks in recent years. Globally, the focus to improve animal health is increasing on new vaccination strategies, improving animal nutrition, and refining the breeding system.

Specifically, vaccination remains central in preventing and controlling infectious diseases in livestocks. It also contributes in reduction of use of antibiotics in livestock farming, a key global trend to counter the risk of food safety and security. We see strong growth opportunities in livestock vaccines especially FMD and ASF with improved subunit and potential mRNA technology, as well as rising industry penetration on the farming side.
Exhibit 9: Efficiency gap of China vs. average global peers in animal protein production would translate into a 6%-26% improvement in grain consumption.

Exhibit 10: Translation of higher efficiency in animal protein production into China grain demand (assuming 26% efficiency gain in hog and 6% in poultry).

Exhibit 11: Livestock vaccines – China: Economic losses, penetration, and room for future market expansions.

Exhibit 12: Pet ownership per capita – China urban versus peers.

Source: AHDB, Wageningen Economic Research, Goldman Sachs Global Investment Research

Source: MOA, China Feed Industry Association, Goldman Sachs Global Investment Research

Source: China Veterinary Drug Association, Company data, Goldman Sachs Global Investment Research

Source: OECD, American Veterinary Medical Association, Animal Health Europe, China Pet Industry White Paper, Goldman Sachs Global Investment Research
Advanced feed additives - green efficiency

We are optimistic on advanced feed products, from special enzymes to probiotics/prebiotics replacing antibiotics and improving grain efficiency, to additives that reduce methane emission from livestocks. Feed additives are no longer just about the essential products (vitamins, minerals and amino-acids). There is so much science and innovations that are going into more advanced animal nutrition products, bringing more efficient feed utilization for production of animal protein, higher food safety, and carbon emission reduction.

We expect a stronger growth outlook in feed additive demand globally and more for China, versus the growth of animal protein production and feed demand. DSM estimates the global feed additives market to grow at 4%-5% CAGR from 2019-2025E, driven by increasing inclusion rates and innovation in compound feed. We estimate the aggregated revenue in animal nutrition from key producers has been growing at an average of 5% in the past three years, and should persist at 5%-10% in the coming years.

Advanced feed additives are relatively new in China, thus possess higher potential due to a lower penetration rate. This can be reflected in the stronger growth rate in methionine (a key feed additive) in recent years in China versus global. The ongoing increase in large commercial farming should also be an additional driver for growth.
Exhibit 13: Global feed additive demand should grow at 4%-6% in the coming years

Exhibit 14: Apparent demand of methionine – China and global

Exhibit 15: DSM’s Bovaer – specialized to suppress the enzyme in cattle for methane formation, leading to a 30% reduction in methane emission

Exhibit 16: Metasmart from Adisseo: Designed for ruminants to be absorbed in remen directly, promoting rumen fermentation and milk production and quality improvement
Precision farming – the next phase of yield gain

Early stages of precision farming have started to take place in China in recent years, mostly enabled by agriculture drones, autonomous driving technology and basic VRT (variable rate technology). According to China Air Transport Association (中国航空运输协会通航分会), agriculture drone sprayer working units have more than doubled each year since 2014, and reached 100k as of 2020A by estimate. Sales of autonomous steering on agriculture machinery have also reached 17,000 units in 2021, versus 5000 in 2019, according to MOA.

Based on the case study of FJ Dynamics, the latest precision farming equipment could help farmers to reduce the cost of inputs (chemical, fertilizer and seed), as well as increase crop yield. Specifically, the cases have seen 2%-25% savings in labor cost, 5%-20% savings in input cost, and 3%-15% in yield enhancement.

We expect the market penetration to continue growing in the coming years, given the improving economics and strong demand generated by labor shortages in rural China. Based on the current existing technology upgrade on the industry agriculture fleet, we estimate the annual market size of early stage precision farming in China could reach US$2.4bn by 2025E, or 2% of the current market size of agriculture machinery, and potentially US$7.8bn longer run.

In addition, water irrigation, an important part of precision farming, has also started its early stage upgrade in China, to address the water stress in selected regions. As of 2019, China’s national average water stress level was 18%, yet can reach as high as 40%-60% in central north and northeast regions (globally, water-stress level is defined as water withdraw/total water resources, and a ratio above 20% is usually considered mid-high level of stress). Upgrading of irrigation technologies, to micro and tunnel irrigation, could reduce water consumption by 32%-36% at this stage. As of 2020, advanced irrigated land through spray, micro and tunnel irrigation reached 350mn mu, (equivalent to 23.3mn ha), or ~ 20% of total arable land, according to Ministry of Water Resource. Based on State Council’s high standard farmland construction plan published in 2021, an additional 110mn mu, or 7.3mn ha of advanced irrigated land would be built nationwide by 2030.

In the long run, precision farming practices will become more sophisticated in terms of more precised crop management, driven by field database collection such as mapped soil condition, weed identification, combined with algorithm/software, and integration with mechanical systems including the VRT technology. Working with ongoing improvement in seeds, better farming practices would provide the next stage of yield gain - in the US, advanced precision farming practices have created a potential market of US$56bn, and would potentially bring additional 70% yield gain in 2016A for corn, from 165 Bushels per acre to 281 Bushels per acre (or 10.4t/ha to 17.6/ha), according to GS US Machinery team, through precision fertilizer, irrigation, planting, spraying, etc.
Specifically in North America where precision farming is in a more advanced stage, GS Machinery, Infra, Sustainable Tech team led by Jerry Revich highlights the precision ag focus is centered around creating a US$56 bn TAM centered on:

- **Yield improvement.** Precision planting solutions by Deere and AGCO deliver up to 5%-10% yield improvement. Self-correcting combine harvesters improve yield collection in the low single digits.

- **Reducing the use of herbicides and pesticides.** Deere’s See & Spray product reduces the use of herbicide by 60%-80%, carries multiple different chemicals which reduce the cost of additional farming passes (labor & fuel), and has the potential to leverage the technology for other applications.

- **Reducing the use of fertilizers.** Deere has rolled out a product for applying nitrogen during planting, thereby reducing nitrogen run off and applying customized dosing to each part of the field.

- **Reducing labor costs.** At its analyst day, Deere outlined the path to a fully
autonomous farm by 2030. As outlined in our autonomous tillage note, we estimate eliminating labor costs in tillage operations could yield US$7.50 per acre in cost reductions and US$2.50 per acre in revenue for precision ag suppliers.

Exhibit 21: Structural input cost reduction attributable to China’s precision ag technologies

Source: Company data, MOA, WIND, NBS, Goldman Sachs Global Investment Research

Exhibit 22: Structural input cost reduction attributable to Deere’s primary precision ag technologies

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 23: Agricultural machinery with RTK and GPS systems – China vs. US

Source: Company data, Goldman Sachs Global Investment Research

Exhibit 24: Precision farming market size – China

Source: Company data, MOA, WIND, NBS, Goldman Sachs Global Investment Research
Exhibit 25: Ecosystem – conventional, early and advanced stages of precision farming – China and US

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<th>Planting stages</th>
<th>Planting</th>
<th>Plant protection</th>
<th>Fertilizer</th>
<th>Irrigation</th>
<th>Harvesting</th>
<th>Advisory &amp; data mgmt</th>
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<tr>
<td>China - Conventional farming</td>
<td>Rice planter, tractor</td>
<td>Airplane, drone, tractor &amp; sprayer</td>
<td>Tractor, sprayer &amp; nozzles</td>
<td>Hose &amp; valve</td>
<td>Combined harvester</td>
<td>Satellite, sensors, AI, and software</td>
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<tr>
<td>Current</td>
<td>Manual, still predominant; Some manned vehicle available but limited usage</td>
<td>Man proposal for early stage of planting</td>
<td>Mostly build as government infrastructure</td>
<td>Manned harvester</td>
<td>n.a.</td>
<td></td>
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<tr>
<td>Key CN players</td>
<td>Zoomlion, Lovol, Dongfeng, First tractor</td>
<td>Mostly SMEs</td>
<td></td>
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| China - Precision farming | Autonomous planter & autonomous upgrade | Autonomous ground-based sprayer, Drone | Autonomous ground-based sprayer, dron | Mostly build as government infrastructure | Auto-steering upgrade; Autonomous harvester | AI platform using satellite & weather data etc. |
| Emerging precision farming | Realized function | Full autonomous driving or assisted driving for inexperienced drivers | Autonomous chemical spraying | Autonomous fertilizer application for early stage of planting | n.a. | Autonomous harvesting |
| Price per unit | Rmb15k-30k | Rmb20k-80k per unit | Rmb40k per unit | Rmb15k-30k | Rmb2k per year | n.a. |
| Yield enhancement | 5-10% | 5-10% in seed | 3-10% labor | 5-10% fertilizer | 5-10% | n.a. |
| Cost/inputs reduction | 5-10% in seed | 2-8% labor | 5% chemical | 2-8% labor | 3-10% labor | 2-8% labor |
| Key technologies | GNSS: Basic Beidou RTK | RTK | Basic Beidou | Fundamental Beidou |
| Sensors: Mechanical: Software integration: | Soil sensors VRT | Soil/Weed sensors VRT Field monitoring | Yield mapping |
| Key CN players | Zoomlion | XAG | iCanAg |

| US - Precision farming | Deere ExactEmerge | Blue River (See & Spray) | Deere ExactApply | Subsurface Dtrp | Deere ActiveYield | Deere FieldConnect & Monsanto Climate Corp |
| Realized function | Prevent overlap and tramping. Plant with higher intensity in more fertile area. | Specifiy target and eliminate weeds, while protecting crop damage. | Improve spraying consistency and minimize drift. | 2/3 less water as overhead irrigation; Improve crop yield. | Record yield for each piece of land; Operation adjustment to working conditions and minimize loss. | Advise farmers according to climate data |
| Price per unit | US$29k/RTK, US$150/planter | 90% in cotton | US$9.8k + US$3.25k | US$399 + US$149/yr |
| Yield enhancement | 5%+ 2-8% in corn 10-15% in soybean | 60% in corn & soybean | 5%+ |
| Key technologies | GNSS: RTK | Soil sensors VRT | Yield mapping |
| Sensors: Mechanical: Software integration: | RTK Soil/Weed sensors VRT Field monitoring | RTK VRT (intelligent nozzle) Field monitoring |
| Key CN players | Deere, CNH, Kubota, AGCO | Deere, CNH, Kubota, AGCO | Deere, CNH, Kubota, AGCO |
| Global aggregators: | Deere, CNH, Kubota, AGCO | Deere, CNH, Kubota, AGCO | Deere |
| Global enablers: | Deere, Trimble, Raven, Hexagon | Deere, Trimble, Equipment Tech, Hexagon |

Source: MOA, Wind, Bloomberg, Company data, data compiled by Goldman Sachs Global Investment Research
Precision farming technology

According to the USDA report in 2016, there were four major categories of precision farming functions being adopted between 1996 and 2013, namely yield mapping, solid mapping, guidance navigation and variable-rate input. Behind these functions, there were various technology enablers.

Global navigation satellite systems (GNSS): The heart of precision farming, it provides the latitude and longitude of a machine operating in a field. The satellite navigation system, such as GPS, Beidou, includes a constellation of multiple satellites orbiting the earth and broadcasting radio signals, and a receiver installed on the machine on the ground.

- **RTK (Real Time Kinematic, <2 centimeters accuracy):** The RTK system consists of a local base station set up nearby the field of operation (within 10 km), together with a receiver on the vehicle. The base station monitors the constellation of satellites and continuously calculates a position, and the receiver sets highly accurate positions to about 2 cm. John Deere launched its RTK system in 2016.
- **China’s Beidou based system (from meters to centimeters):** In 2018, China Beidou started to offer more enhanced services with multiple levels of accuracy in ranges of meter, decimeter, and centimeter.

Sensor technologies: Used for planting decision and yield recording

- **Field data collection and planting decision-making:** Field information such as soil moisture, compaction, fertility, as well as crop conditions such as leaf temperature, plant water status insect-disease-weed infestation etc. Such data could be used to advise irrigation and spraying etc.
- **Yield mapping in harvesting:** A yield mapping system measures and records the amount of grain harvested using a yield monitor sensor on the harvester. Inputs can be adjusted to maximize the productivity.

Mechanical systems:

- **Variable rate technologies (VRT):** VRT refers to mechanical systems that can apply various types of substances such as fertilizers, pesticides, seeds and waters on to planted crops. It consists of a controller of material flow, a position system, and a map of desired intensity of substance.
- **Continuous Variable Transmission (CVT) for tractors:** It consists of a computer-based intelligent control system that can automatically adjust engines according to working conditions as well as the functioning of Power Take off (PTO) units in the power trains. Deere's IVT system allows the engine to communicate 100 times a second with the transmission, and provides a seamless range of speeds between 0.03 mph (50 meter/hr) to 26 mph (40 km/hr) with no gaps and no clutching, enabling a more accurate plowing of uniform depth.

Software & information systems:

- **Autonomous-steering/Autonomous-pilot:** Besides saving labor cost, high accuracy auto-steering could also help improve efficiency e.g. more uniform planting patterns that maximize land utilization, avoiding overlapping of input usage, avoid ramping over crops thereby supporting crop yield.
- **Decision Support Systems (DSS):** Using a big data system that examines weather, soil, and plant conditions and provides customized advice to farmers on optimal reactions.
The self-sufficiency of staple food and food security have been policy priorities for many years, and increasingly in focus since 2020. We highlight key recent policies of the Chinese government that addressed the definition of food security, seeds, grain imports, as well as food waste management – paving the way to improving output and self-sufficiency of China agriculture food supply.

### Key policies related to food security

The food security white paper (中国的粮食安全白皮书) published by the State Council in 2019, defined China food security in view of policies, in five major benchmarks:

1) Grain output - arable land, output, and yield. The policy stated that China’s household food output was 470kg per capita in 2019, up 14% compared to its level in 1996, and above the global average during the same period. Average grain yield per hectare improved 25% over the period, and was higher or on par with global average. Nevertheless, the policy continues to promote further enhancement in grain output. Specifically, on arable land, the policy requires strict protection of arable land, higher mix of high-standard farmland, grain-specialized functional region, and improvement on efficiency of water utilization through advanced irrigation and water saving projects.

2) Grain self-sufficiency: China managed to maintain a self-sufficiency ratio of over 95% for major grains as of 2019, while maintaining its absolute self-sufficiency of staple grains (wheat and rice).

Other key factors monitored are reserves and logistics (including the 670mnt of reserve storage capacity) and food for poverty – generally consistent with the UN’s definition of food security.

The most important change is the recent seed industry revitalization plan ("种业振兴行动方案"). First promoted by President Xi in 2021, China’s seed industry vitalization plan sets forth to urge efforts on achieving self-reliance within the sector through independent and controllable germplasm resources. Within the plan, the government highlighted the importance of local germplasm resources, aiming to consolidate the
market by supporting 52 seed production counties and 100 regional breeding bases in selection with funding cap risen from Rmb1bn to Rmb2bn. In addition, the policy also stepped up its effort on IP protection through revised Seeds Law ("种子法"), introducing the concept of “essentially derived variety” (EDVs) to distinguish those originally developed varieties from derived ones. Under the stringent IP enforcement framework, infringement on plant variety would be punished by the strictest practice, according to the action plan.

China has long established a tariff-rate quota scheme for its corn, wheat and rice imports based on Interim Measures of Import Tariff Quotas of Agricultural Products ("农产品进口关税配额管理暂行办法") since 2003, aiming to protect its domestic grain industry. For 2022, China sets the quota at 9.4mnt of wheat, 7.2mnt of corn, and 5.3mnt of rice to be imported at 1% tariff, while any imports in excess of the quota would be applied at a 65% tariff instead.

In terms of food waste management, China initiated the effort in 2013, with the Clean Plate Campaign (粮食节约行动方案/光盘行动). A comprehensive action plan was later introduced by the State Council in 2021, focusing on reducing food waste along the food supply chain, from grain production, storage, transportation, processing, to retail and wholesale consumption, including fines imposed on excessive waste of food. We estimate current food waste would account for 9% of meat consumption, and 13% of cereal in China.

**Cyclical outlook in the near term**

We expect Chinese import of corn and soy bean to remain elevated yet decelerating for the 2021/22 planting year, versus 2020/21, driven mostly by softened feed demand as lower hog feed will be partly offset by lower substitution of wheat. However, uncertainty in weather conditions and relatively lower inventory versus past years, continue to impose risks on grain balance in our view.

Based on forecast by China Agriculture Outlook Committee (CAOC) MOA, corn and soybean imports are expected to reach 20mnt and 93mnt in 2021/22 respectively, versus 30mnt and 113mnt a year ago. CAOC also forecasts the import would be 18mnt for corn in 2022/23, and 95 mnt for soybean. According to the July report by CAOC, the current growth condition of corn especially for the northeast region is better than a year ago, given meteorological conditions in most corn producing areas are generally better than the previous year. On soybean, uncertainties in meteorological conditions remain - the northeast region is seeing more rainfall, yet overall soybean growth conditions remain reasonable.
Exhibit 28: China import of major agriculture products per annum = 2000-2023E, and LT outlook and scenarios

- **Annual import of major ag products (mnt)**
  - Soybean
  - Wheat
  - Rice
  - Animal protein

- **Source:** NBS, MOA, FAO, USDA, Goldman Sachs Global Investment Research

Exhibit 29: China import of major agriculture products in arable land equivalent = 2000-2023E, and LT outlook and scenarios

- **Annual import - in arable land equivalent (mn ha) and as % of China**
  - Top producers
  - United States
  - China
  - Brazil
  - Argentina
  - European Union
  - Others

- **Source:** NBS, MOA, FAO, USDA, Goldman Sachs Global Investment Research

Exhibit 30: Daily protein consumption pattern – China versus peers

- **Daily food consumption g/day/person**
  - Total demand
  - Others
  - Feed
  - Other feed

- **Source:** FAO, NBS, Goldman Sachs Global Investment Research

Exhibit 31: Major agriculture products production and trade – global, China

- **Annual import - in arable land equivalent (mnt) and as % of China**
  - Top exporters
  - United States
  - China
  - Brazil
  - Argentina
  - New Zealand

- **Source:** FAO, Customs data, data compiled by Goldman Sachs Global Investment Research

Exhibit 32: China major grain S/D balance outlook

- **China corn S/D**
  - Domestic output
  - Import
  - Total supply

- **Saudi Arabia corn S/D**
  - Domestic output
  - Import
  - Total supply

- **China soybean S/D**
  - Domestic output
  - Inventory
  - Total supply

- **Source:** FAO, USDA, MOA, Goldman Sachs Global Investment Research

Exhibit 33: Inventory days of major grains – China

- **Inventory forecasts based on MOA and JCI**

- **Source:** JCI, MOA, Goldman Sachs Global Investment Research
China agriculture supply – the inefficiencies

Exhibit 34: Fertilizer usage intensity – mainland China versus peers

Exhibit 35: Pesticide usage intensity – mainland China versus peers

Exhibit 36: Shrinking work force in the rural population – China

Exhibit 37: Cost inflation in labor and land – corn, China

Unit labor wages in farming rose nearly 4x in the past decade, similar trend in land cost

Exhibit 38: Production cost of corn – China versus peers

Exhibit 39: Production cost of soybean – China versus peers

Source: FAO, data compiled by Goldman Sachs Global Investment Research

Source: NBS, Wind, data compiled by Goldman Sachs Global Investment Research

Source: MOA, Wind, data compiled by Goldman Sachs Global Investment Research

Source: NDRC, USDA, CONAB, data compiled by Goldman Sachs Global Investment Research

Source: NDRC, USDA, CONAB, data compiled by Goldman Sachs Global Investment Research
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**Themes**

- China de-carbonization
- Circular Economy
- The Future of Battery
- The Green Technology Cycle
- EV battery metal recycling
- ESG of the Future
- Balanced Bear Despair
- The Post-Pandemic Cycle
- The PM’s Guide to ESG
- Age of Automation
- China Regulations
- Automotive Software
- India Mobility
- EM ex-China asset class
- Top of Mind
- Top Projects
- China A Shares
- EUV 2.0
- Electric Vehicles
- Carbonomics
- China Industrial Tech
- Europe Digital Economy
- India Internet
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- Blockchain
- ...and more