Development of China's Grain Conservation and Loss Reduction Standards System

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1. Strategies for Reducing Grain Losses at Different Stages

Grain loss reduction is a major issue that matters to global food security and sustainable development. Grain losses not only affect economic benefits, but also exacerbate resource waste and produce a negative impact on the environment. Throughout the entire process from grain production to consumption, losses and waste of varying degrees occur at different stages. This complex and multi-level process involves a number of stages, such as planting, reaping, harvesting, storage, transportation, processing, retailing, and consumption. An effective grain loss reduction strategy should cover all these stages to reduce grain losses and waste through scientific management and technologies. Reducing losses at each of the eight stages of the grain industry chain by adopting effective strategies is vital to ensuring food security, minimizing food waste and enhancing sustainability.

2.1 Planting

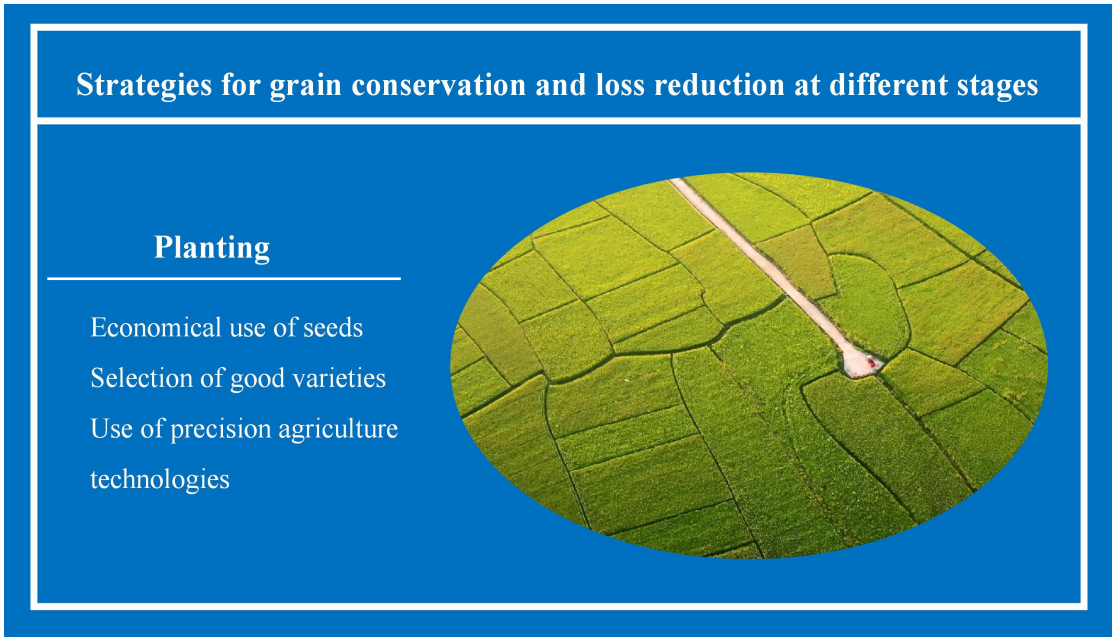

Figure 1. Strategies for grain conservation and loss reduction during planting

2.2 Reaping

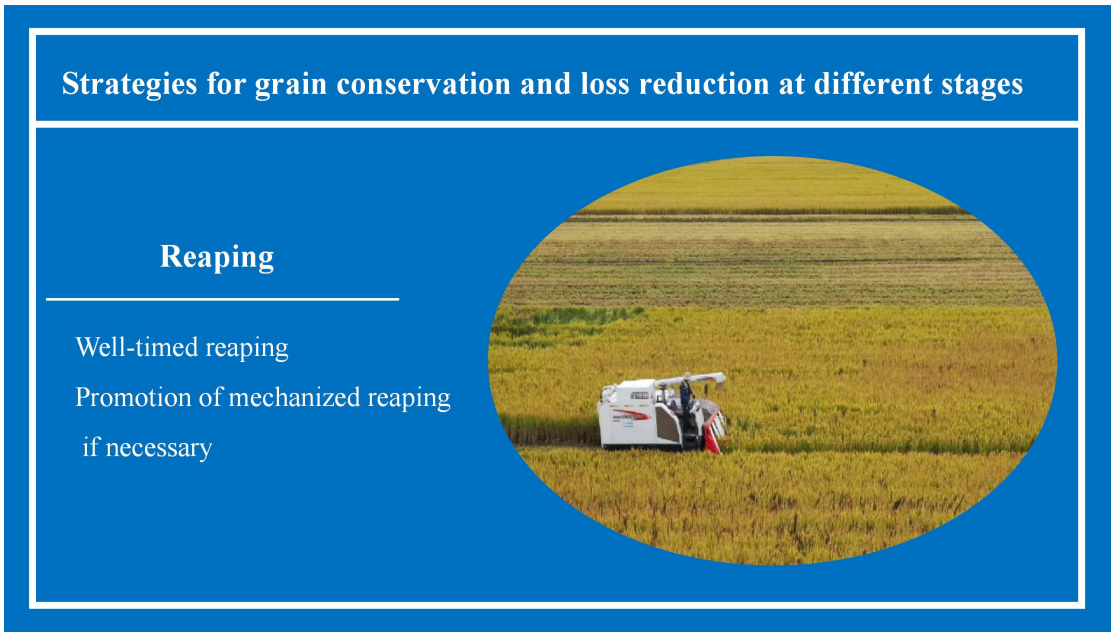

Figure 2. Strategies for grain conservation and loss reduction during reaping

2.3 Harvesting

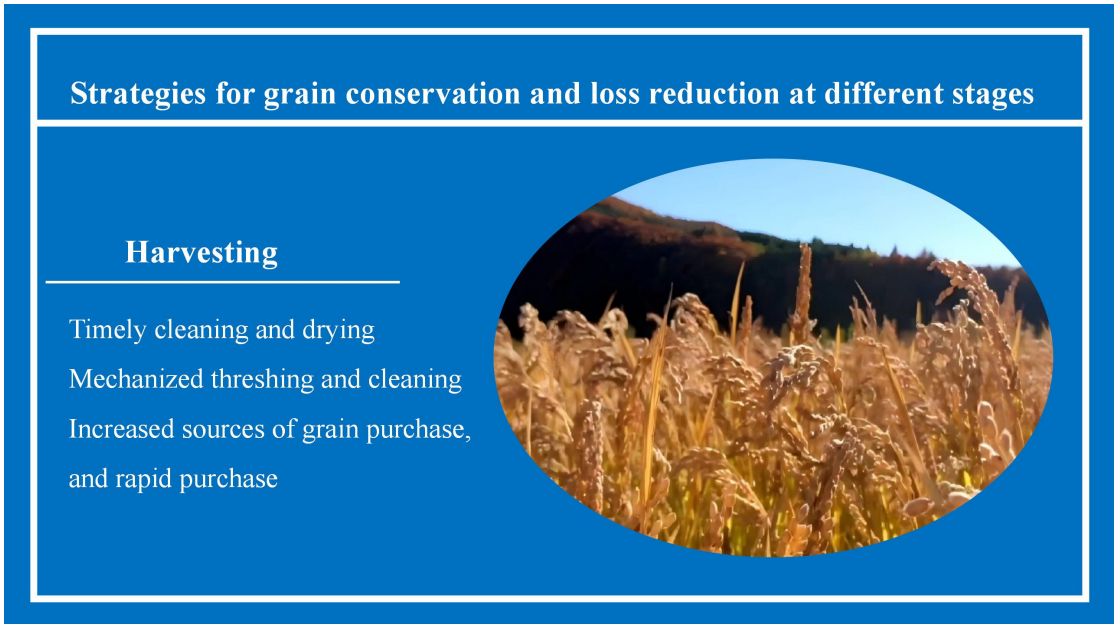

Figure 3. Strategies for grain conservation and loss reduction during harvesting

2.4 Storage

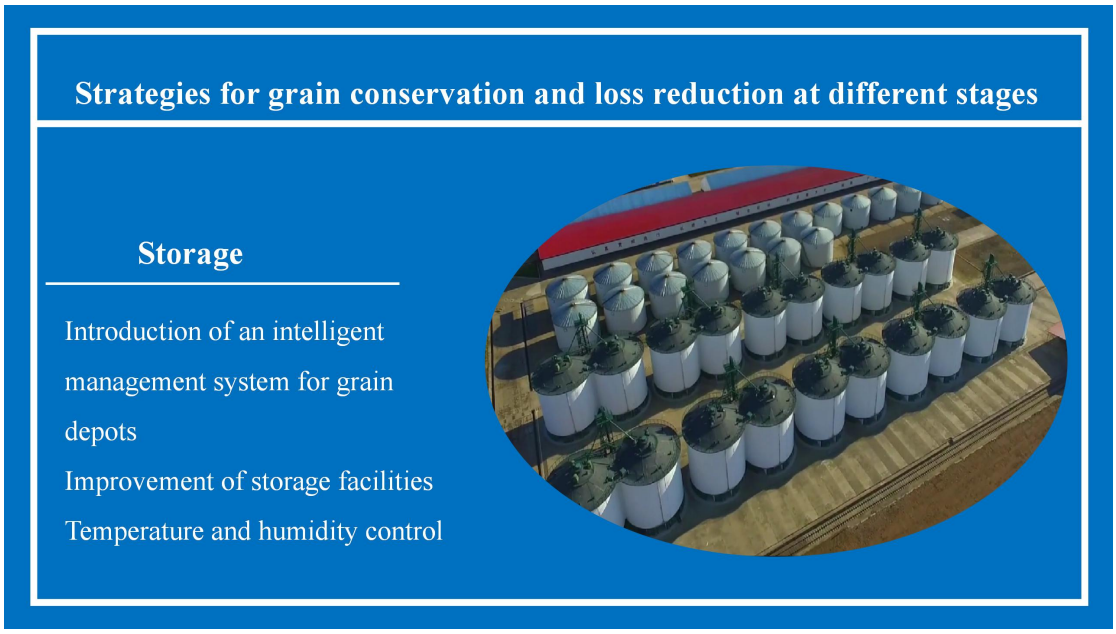

Figure 4. Strategies for grain conservation and loss reduction during storage

2.5 Transportation

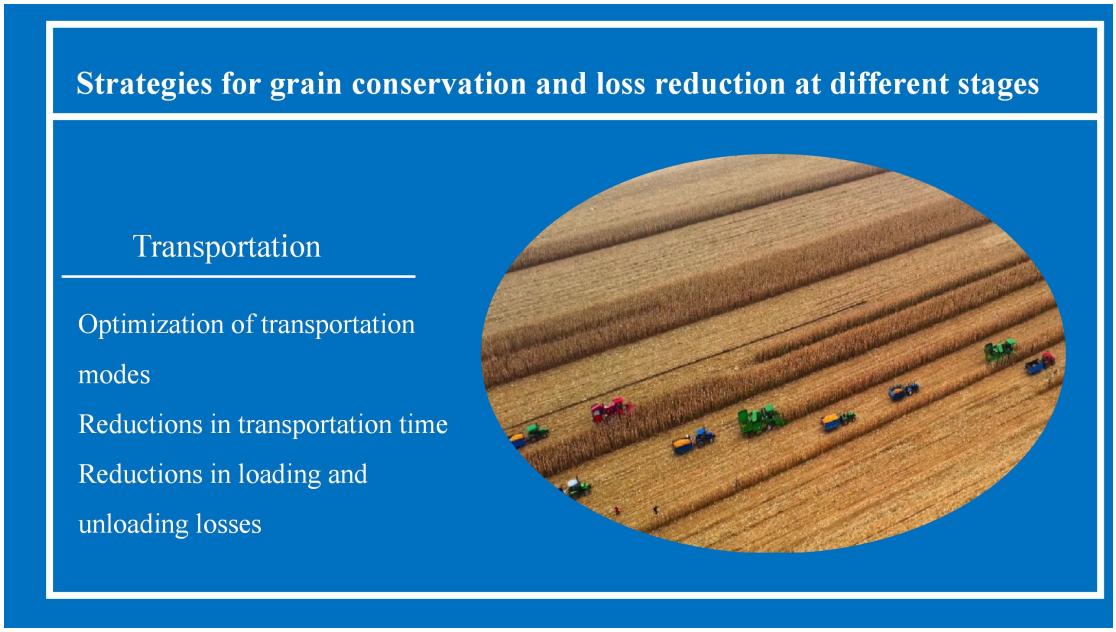

Figure 5. Strategies for grain conservation and loss reduction during transportation

2.6 Processing

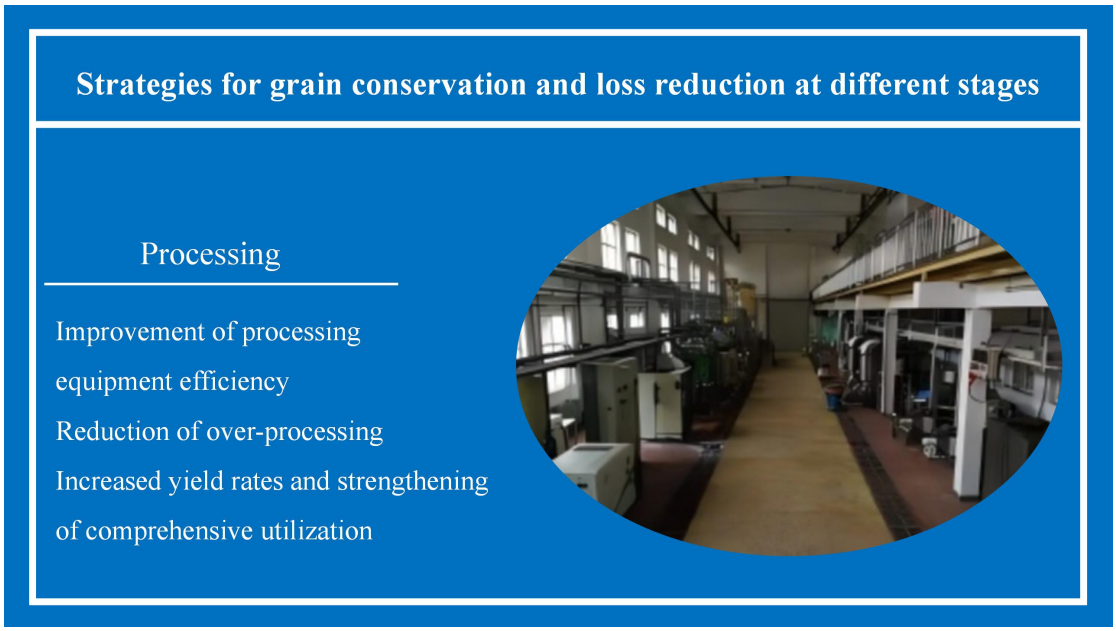

Figure 6. Strategies for grain conservation and loss reduction during processing

2.7 Sales

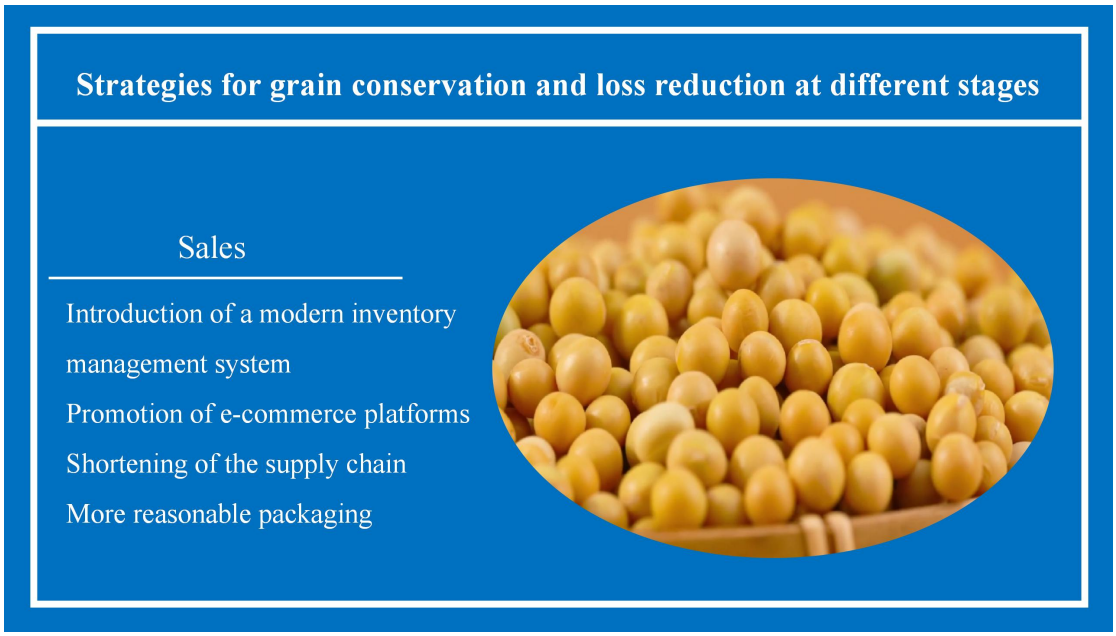

Figure 7. Strategies for grain conservation and loss reduction during sales

2.8 Consumption

Figure 8. Strategies for grain conservation and loss reduction during consumption

3. Legal and Policy Frameworks in China

3.1 Anti-Food Waste Law

The Anti-Food Waste Law creates a systematic and targeted legal framework for reducing post-harvest grain losses, which deals with grain losses at different stages, including harvesting, storage, processing and circulation.

3.1.1 Purpose and basic principles

Purpose. The Anti-Food Waste Law articulates the objective of ensuring the efficient use of food resources and food security by reducing waste. The objective embodies the priority given to post-harvest grain loss reduction in the top-level design of the law.

Basic principles. The law stresses "whole-process conservation" and "society-wide participation", and has created a multi-agent participation mechanism for reducing grain losses through a combination of government regulation, business self-discipline and public oversight.

3.2.1 Legal framework for post-harvest grain loss reduction

Post-harvest grain loss reduction involves multiple stages from farm to table, and the law regulates the relevant agents and their behaviors at each stage. With respect to grain harvesting, the law mandates the promotion of scientific harvesting and storage technologies to minimize losses at this stage. The relevant measures include: (1) encouraging and supporting the application of modern agricultural technologies, such as mechanized reaping, and scientific

drying. (2) Assigning local governments the responsibility of guiding scientific practices among farmers to ensure the promotion of loss reduction technologies.

With respect to grain storage, the Anti-Food Waste Law outlines the following measures: (1) encouraging grain depots and farmers to use advanced grain storage technologies, such as controlled atmosphere storage and airtight storage. (2) Requiring enterprises and grain depots to conduct regular inspections, thus preventing losses from pests and mildew. (3) Encouraging the construction of regional grain reserve centers to mitigate risks associated with decentralized storage.

With respect to grain processing, grain losses are primarily reduced through technological upgrading and fine management at this stage. As such, the law sets forth the following requirements: (1) processing enterprises should adopt efficient and low-consumption equipment and processes to maximize the grain conversion rate. (2) Unreasonable processing practices, such as over-polishing of rice and unnecessary shelling, should be strictly restricted.

Loss reduction in the process of grain circulation is one of the priorities in the law. Specific measures include: (1) reducing losses during transportation by encouraging the use of specialized transportation tools to prevent exposure and damage. (2) Optimizing distribution by strengthening supply and demand matching to reduce overstocking or waste as a result of expiration. (3) Intensifying inspection of wholesale and retail business to prevent losses due to negligence in management.

3.1.3 Supervision and punishment mechanisms

Supervision mechanism. Governments at all levels need to release regular reports on grain losses, and disclose the loss rates at each post-harvest stage. They should prioritize grain storage and circulation in spot checks to identify and correct problems in a timely manner.

Legal liability. Units or individuals that have caused severe grain losses as a result of poor management or technological inadequacy will be given administrative penalties; those with serious violations may be held criminally liable.

3.1.4 Public and social participation

Apart from regulating specialized processes, the law also outlines measures that advocate society-wide food waste reduction. (1) Public awareness education. Publicity and educational campaigns should be organized to enhance public awareness of grain loss reduction. (2) Technology research and development support. Research institutes and enterprises are encouraged to develop low-cost loss reduction technologies. (3) Industry self-discipline. Industry associations are required to formulate codes of conduct on waste reduction, and

supervise their implementation.

3.1.5 Summary

The Anti-Food Waste Law provides a legal framework that systematically deals with post-harvest grain loss reduction, and pursues governance on all fronts from technology promotion, regulation of behaviors to supervision and management. This legislation attests to the Chinese government's strong commitment to food security and sustainable development. However, its success depends on sound supporting regulations, and robust enforcement by local governments and enterprises. Through the full implementation of the law, China is expected to significantly reduce post-harvest grain losses, providing strong safeguards for achieving the vision of "zero hunger" and the Sustainable Development Goals (SDGs).

3.2 Food Security Law

As the core law for ensuring China's food security, the Food Security Law (hereinafter referred to as the "FSL") contains systematic provisions on post-harvest grain loss reduction throughout the chain from production, storage, circulation to consumption. The FSL provides a complete legal framework in this regard, and mainly comprises the following.

3.2.1 Objective and fundamental principle of the legislation on post-harvest grain loss reduction

The FSL articulates the core principle of "grain conservation and loss reduction", emphasizing the objective of improving grain efficiency. Throughout the full life cycle of grain, loss reduction is particularly emphasized in post-harvest processes to minimize waste, improve resource use efficiency, and provide a legal guarantee for China's food security. The objective of the FSL with respect to grain conservation and loss reduction is to reduce losses in grain storage, transportation and processing by regulating post-harvest processes, and ultimately enhancing food security and supply. The fundamental principle is to create a synergy among the government, enterprises and society through innovative technologies, standardized management, and participation by all.

3.2.2 Special provisions on post-harvest grain loss reduction

Technical support and technology promotion. The FSL requires accelerated research, development and promotion of post-harvest grain handling technologies. (1) Storage technologies. It calls for the application of green grain storage and intelligent storage technologies to minimize losses due to environmental factors, pests, and storage conditions. (2) Transportation technologies. It encourages the use of efficient and eco-friendly grain transportation equipment to reduce physical losses and damage to quality during transportation.

(3) Processing technologies. It advocates the promotion of grain-saving processing technologies to reduce the waste of edible parts during processing.

3.2.3 Regulation and related standards

The law stipulates that the State shall establish and improve industry standards on grain storage, transportation and processing. (1) Storage standards. It provides for granary design, humidity control, climate adaptability and other standards to ensure the long-term grain storage quality. (2) Transportation standards. It requires enterprises to adopt transportation modes that comply with the relevant regulations to minimize damage and waste. (3) Processing standards. According to the law, processing enterprises must optimize their processes to improve the yield rate.

3.2.4 Government's responsibilities

The FSL clarifies the key roles of the government in reducing post-harvest grain losses. (1) Policy support. The government should support the construction and improvement of grain storage facilities through fiscal subsidies and tax incentives. (2) Supervision mechanism. The government should establish a mechanism for the supervision of post-harvest processes to ensure the implementation of loss reduction measures. (3) Publicity and education. The government should organize grain conservation education nationwide, and advocate reductions in waste during processing and consumption.

3.2.5 Enterprises' obligations

The FSL clarifies the responsibilities grain-related enterprises should assume. (1) Self-inspection and compliance. Enterprises must develop post-harvest grain loss reduction plans, and accept regular inspections by the government. (2) Technology upgrading. Enterprises are required to adopt cutting-edge storage and transportation technologies to minimize losses. (3) Accountability. The law prescribes a fine and accountability mechanism for enterprises that have caused significant grain losses due to poor management.

3.2.6 Social participation and supervision

A loss reduction network involving all sectors of society should be built through multi-party collaboration. (1) Industry associations. The law encourages industry associations to formulate technical guidelines and promote best practices. (2) Public participation. It advocates conservation-oriented consumption, and reductions in food waste. (3) Whistle-blowing mechanism. Public whistle-blowing channels should be set up to combat non-compliance.

3.2.7 International cooperation

Since post-harvest grain loss reduction is an issue of global concern, the FSL encourages

international technological exchanges and cooperation. (1) Technology introduction. International advanced technologies and experiences should be absorbed to improve grain loss reduction in China. (2) Data sharing. Data exchange with international organizations should be strengthened to optimize post-harvest loss reduction measures.

3.2.8 Summary

China's Food Security Law offers a comprehensive legal framework for post-harvest grain loss reduction on all fronts, from technology innovation to policy support, and from enterprise supervision to social mobilization. Guided by the goal of building a conservation-oriented society, the framework aims to promote a shift in the focus of food security from "increasing production" to "improving quality", with emphasis on synergy between technology, management and rule of law. It constitutes a food security system with Chinese characteristics.

3.3 Related action plans

The Action Plan on Saving Food issued in 2021 elaborates the specific actions to save grain and reduce losses at different stages. According to the action plan, by 2025, measures for grain conservation and loss reduction at different stages of the grain industry chain will be strengthened and refined, more obvious results will be secured in grain conservation and loss reduction, and the institutional, standards and monitoring systems for grain conservation and loss reduction will be basically in place. For example, in terms of harvesting, technical guidelines on loss reduction during mechanized harvesting of rice, corn, wheat and soybean will be developed and revised; initiatives for green storage improvement and pilot projects for the standardization of green grain storage will be encouraged. In terms of transportation, demonstration projects for logistics standardization will be launched, a standardized and information-based bulk grain transportation service system will be developed, and technologies for standardizing means of transportation will be studied. In terms of processing, standards on the processing of wheat flour and other rations, as well as edible oil will be developed and revised, moderate processing standards will be upgraded, and indicators such as processing accuracy will be reasonably determined. In terms of consumption, the anti-food waste system will be strengthened for the catering industry, and the relevant industry standards and service specifications will be improved. In addition, the development of standards for the entire grain industry chain that meet the requirements of grain conservation and loss reduction will be accelerated, and national and industry standards for promoting grain conservation will be developed. Industry associations should develop and issue group standards on loss and consumption reduction throughout the chain.

The Action Plan for Grain Conservation and Anti-Food Waste issued in 2024 envisages a new round of initiatives for grain conservation and anti-food waste over the next three years. The

action plan mainly involves actions to save grain and reduce grain losses, enhance public awareness of grain conservation, combat waste in the catering industry, combat waste in canteens, and intensify statistical surveys on food losses and waste.

4. Classification and Principles of Development of a Grain Conservation and Loss Reduction Standards System in China

4.1 Classification of related standards

In short, a standards system is a combination of various standards within a certain range, which constitute a scientific organic whole as they are intrinsically linked. China's standards can be divided into government standards and market standards based on standard setters. Unlike in foreign countries where association standards or enterprise standards are in the majority, government standards prevail in China. Government standards include national, industry and local standards; while market standards include group standards and enterprise standards. More specifically, national standards are developed and approved by national standardization authorities, and enforced nationwide; industry standards are formulated and approved by competent authorities in a specific industry, and enforced within the industry; local standards are made and approved by standardization authorities in provinces, autonomous regions, municipalities directly under the central government, and cities with subordinate districts, and enforced mainly within the corresponding administrative jurisdictions. Group standards are formulated by social groups or industry associations in partnership with relevant stakeholders based on their technical and market needs; enterprise standards are made by enterprises to meet their production and operation needs.

4.2 Principles of development

4.2.1 Clear objectives and completeness

The primary principle of developing a grain conservation and loss reduction standards system is clear objectives. To put it differently, each standard should set clear objectives for grain conservation and loss reduction. At the center of the standards system is a series of measures and norms that ensure grain loss and waste reduction at different stages. The core objectives of the system are:

- To reduce losses during production and circulation: clear specifications and technical standards should be formulated for production, harvesting, storage, and transportation. For example, harvesting methods, suitable storage conditions, and temperature control standards during transportation should be clearly defined based on the realities of different crops to assist farmers and logistics service providers in minimizing losses.

- To reduce food waste during consumption: grain conservation measures should be developed for retail, catering and household consumption, especially those involving food safety and preservation, reasonable purchase and food storage management. These measures should help consumers improve awareness and reduce waste.

Meanwhile, "completeness" means that the standards system should not only deal with grain losses across the grain industry chain, but also include relevant technical standards, management specifications and a policy framework. A complete system of grain conservation and loss reduction standards should cover the entire food supply chain from farm to table, including:

- Agricultural production: such as post-harvest handling standards, and technical standards on grain drying and storage.
- Supply chain management: such as standards on temperature control during grain transportation, cold chain management requirements, and technical standards on packaging and distribution.
- Food retail and consumption: such as standards on food labeling, shelf-life management, and food donation.
- Waste disposal: including food waste recycling standards, such as conversion into fertilizers or bioenergy.

Through this complete set of standards, the goal of grain conservation and loss reduction can be effectively implemented at every stage of the entire chain to minimize grain losses.

4.2.2 Appropriate hierarchy and clear division

The second key principle is an appropriate hierarchy and clear division. As the food supply chain involves multiple stages and stakeholders, the standards should be hierarchically structured to allow different participants to implement the corresponding measures to their respective roles and responsibilities.

Appropriate hierarchy: the standards system should comprise different levels based on the complexities, technical requirements and management capabilities at each stage. For example, standards for agricultural producers need to cover post-harvest management, crop handling and preliminary storage technologies, while those for logistics enterprises should focus on temperature control and humidity management during transportation as well as the timeliness of transportation. Standards for retailers and consumers should emphasize reasonable shelf life management, food storage and improvement of purchasing behaviors.

Clear division: standards at each level should clearly specify responsibilities and tasks. For example, standards associated with logistics should define parameters for temperature and humidity control during transportation, storage conditions for different types of grain, and the corresponding penalties and improvement measures for violations. Standards for agricultural producers should cover the timing of harvesting and handling methods during transportation. Consumer-side standards should prioritize education and behavior guidance to help consumers reduce unnecessary waste.

Moreover, grain conservation and loss reduction measures required by different countries and regions vary, depending on differences in climate, technology and economic development. Therefore, the standards system should be hierarchized in a way that takes into account these differences to adapt to a wide range of grain production and consumption environments. For example, tropical countries may pay more attention to moisture-proof technologies, while frigid-zone countries may need to strengthen the management of cold chain transportation.

With an appropriate hierarchy, a grain conservation and loss reduction standards system would enable all participants to take targeted measures at each stage, thus ensuring that the standards are operable and effective.

4.2.3 Borrowing and adaptation of international standards

Since grain conservation and loss reduction is a global issue, in building a standards system in this regard, it is essential to draw upon international standards and adapt them to the realities of China and specific regions. Drawing upon international standards delivers the following key benefits. International experiences and best practices: By drawing on the grain conservation and loss reduction standards developed by the United Nations Food and Agriculture Organization (FAO), the World Food Programme (WFP) and other international organizations, China can make good use of global best practices and experiences. For example, the FAO standard on reducing post-harvest grain losses puts forward technical solutions such as improving grain storage facilities and enhancing cold chain logistics management, which have been successfully applied in different countries and regions around the world.

Global market consistency: In a globalized food market, standards to reduce food waste are particularly important in cross-border food trade. By borrowing international standards, China can improve the compatibility of its own standards with international ones, and reduce technical barriers in cross-border food circulation. Unified standards can help raise the transparency and operability of international trade, and reduce grain losses in cross-border transportation.

However, borrowing international standards does not mean accepting them as they are. Grain

conservation and loss reduction standards should be tailored to local economic, social and climate conditions. In low-income countries, for example, certain high-tech solutions in international standards may prove infeasible due to poor infrastructure there. In this case, standard setters should adapt them to local conditions by promoting affordable and efficient technologies, such as low-cost storage facilities using local materials.

Further, international standards should be drawn upon in a way that takes into account cultural and social convention differences. For instance, in some regions, food waste is closely linked to local food culture and social customs, necessitating a full understanding of the local cultural context in standard setting. These standards should incorporate education and behavior guidance, rather than technical regulations alone. It should be noted that the scope of implementation varies across the five types of standards, with national and industry standards having a broader reach than local standards.

4.3 Examples of typical standards

4.3.1 Wheat (GB1351-2023)

Wheat (GB1351-2023) is a standard issued by the National Standardization Administration of China, which outlines the following norms and requirements for grain conservation and loss reduction during production and processing.

The norms for grain conservation and loss reduction during production focus on wheat planting, harvesting, and storage, involving the following key areas: (1) **variety selection**. High-yield and disease- and pest-resistant wheat varieties should be selected to minimize yield loss caused by diseases and pests; varieties that can adapt to regional climate conditions should be selected to improve yield stability. (2) **Field management**. Scientific fertilization: accurate fertilization should be adopted according to soil conditions and wheat growth stages to prevent resource waste caused by excessive fertilizer use; disease and pest control: green control measures should be taken to reduce the use of pesticides and ensure the quality of wheat. (3) **Harvesting requirements**. Harvesting should be well-timed to ensure that wheat kernels are fully ripe but not over-ripe, which may lead to kernel loss; mechanized harvesting should be adopted to increase harvesting efficiency and reduce grain waste in the field. (4) **Storage norms**. The temperature and humidity in the storage environment should be controlled to prevent mildew and pests; mildew and pest control equipment and technologies should be used.

The norms for grain conservation and loss reduction during processing emphasize rational utilization of wheat resources and reduction of waste during process, mainly involving the following areas: (1) **raw materials inspection**. Wheat quality indicators such as moisture and impurities should be strictly controlled to prevent waste in subsequent processing due to

substandard raw materials; an efficient quality inspection process should be established. (2) **Cleaning**. The equipment and processes for the removal of impurities should be optimized to ensure the preservation of wheat kernels in their most intact form and minimize damaged wheat kernels. (3) **Processing**. Fine grinding should be adopted to increase the flour yield and reduce the amount of editable parts left in the bran; multi-stage separation should be adopted to realize accurate classification and utilization of flour of different particle sizes. (4) **By-product utilization**. By-products such as bran and germ should be further processed to produce feed or food additives, thus reducing resource waste. (5) **Finished product packaging and storage**. Eco-friendly materials and scientific packaging design should be used to prevent grain losses during transportation or storage; the supervision of post-delivery storage conditions should be strengthened.

<table>
<tr><th rowspan="2">Grade</th><th rowspan="2">Test weight/(g/L)</th><th rowspan="2">Defected kernel/%</th><th colspan="2">Impurities/%</th><th rowspan="2">Moisture/%</th><th rowspan="2">Color and odor</th></tr>
<tr><th>Total</th><th>Including: inorganic impurities</th></tr>
<tr><td>1</td><td>≧790</td><td>≦6.0</td><td rowspan="6">≦1.0</td><td rowspan="6">≦0.5</td><td rowspan="6">≦12.5</td><td rowspan="6">Normal</td></tr>
<tr><td>2</td><td>≧770</td><td rowspan="2"></td></tr>
<tr><td>3</td><td>≧750</td><td rowspan="2">≦8.0</td></tr>
<tr><td>4</td><td>≧730</td></tr>
<tr><td>5</td><td>≧710</td><td>≦10.0</td></tr>
<tr><td>Substandard</td><td><710</td><td>-</td></tr>
<tr><td colspan="7">Note: "-" means no requirements.</td></tr>
</table>

Figure 9. Quality indicators in Wheat (GB1351-2023)

4.3.2 Soybean (GB1352-2023)

Soybean (GB1352-2023) is a standard issued by the National Standardization Administration of China, which outlines the following norms for grain conservation and loss reduction during production and processing.

The norms for grain conservation and loss reduction during production focus on soybean planting, harvesting and storage, involving the following key areas: (1) **variety selection**. High-yield quality soybean varieties with good resistance and wide adaptability should be selected to ensure efficient and stable production, and reduce losses due to natural conditions from the source. (2) **Field management**: sowing quality. Sowing should be carried out at specified densities and depths to prevent low germination rates or seedling losses caused by improper planting methods. Water and fertilizer management. Scientific fertilization should be implemented to prevent fertilizer waste; reasonable irrigation should be adopted to avoid reductions in soybean production as a result of insufficient or excessive irrigation. Disease and pest control. Green control technologies should be adopted to reduce yield loss caused by diseases and pests. (3) **Harvesting methods**. Harvesting should be well-timed to prevent soybean quality degradation or yield loss due to untimely harvesting; harvesting equipment should be optimized to minimize mechanical losses during harvesting. (4) **Storage and transportation**. Scientific drying techniques should be adopted to keep the moisture content of soybeans within a safe range, thus reducing the risk of mildew or pest infestation; soybeans should be stored in well-ventilated places protected from moisture and pests, and mechanical damage should be avoided during transportation.

The norms for grain conservation and loss reduction during processing emphasize the reasonable utilization of soybean resources to reduce waste during processing, mainly involving the following areas: (1) **cleaning**. raw soybeans should be strictly cleaned before processing to remove impurities and inferior soybeans, and reduce energy waste in subsequent processes. (2) **Screening and grading**. Soybeans should be graded by quality to ensure that only high-quality raw materials are further processed, thus increasing processing efficiency and reducing resource waste. (3) **Crushing and dehulling**. Efficient and energy-saving equipment should be used for crushing and dehulling to minimize mechanical losses while reducing the waste of usable soybeans. (4) **Oil production and by-product utilization**. Low-temperature oil extraction or other efficient technologies should be adopted during oil production to maximize oil extraction rates and minimize residual oil; by-products such as soybean meal and hulls should be used as feed or raw food materials to prevent waste. (5) **Quality control**. A comprehensive quality monitoring system should be established to ensure processing quality at each stage, and reduce resource waste caused by rework or scrapping of substandard projects. (6) **Packaging and storage**. Environmentally-friendly and durable packaging materials should be used to prevent product losses due to packaging damage; temperature and humidity control should be strengthened during storage to ensure stable quality of products during their shelf life.

Table 1. Revision of the percent of damaged kernel in Soybean (GB1352-2023)

Grade	Original standard of damage particle rate	New standard of damage particle rate
1	≦1.0%	≦4.0%
2	≦2.0%	≦6.0%
3	≦3.0%	≦8.0%
4	≦5.0%	≦10.0%
5	≦8.0%	≦12.0%

4.3.3 Wheat Flour (GB/T_1355-2021)

Wheat Flour (GB/T_1355-2021) is a standard issued by the National Standardization Administration of China, which outlines the following norms for grain conservation and loss reduction during production and processing.

The norms for grain conservation and loss reduction during production focus on the selection of raw materials, the storage and transportation of processed raw materials, and scientific wheat blending, involving the following key areas: (1) **selection and handling of raw materials**. High-quality wheat that meets national standards should be selected to ensure the content of impurities in raw materials is controlled within the specified range, thus preventing losses due to excessive impurities; the equipment and processes for cleaning wheat and removing impurities should be optimized to reduce material losses during screening. (2) **Storage and transportation of processed raw grains**. Moisture-proof, pest-proof, and mildew-proof measures should be taken during the storage and transportation of wheat to prevent wheat quality degradation or waste resulting from improper storage and transportation conditions; low-temperature and low-humidity storage should be emphasized, especially during long-term transportation, to reduce losses due to mildew or pests. (3) **Scientific wheat blending**. Processing plants are required to scientifically blend wheat varieties according to the purposes and quality targets of wheat flour to maximize the utilization rate of raw materials, and prevent resource waste resulting from the excessive use of high-cost varieties.

The norms for grain conservation and loss reduction during processing focus on technology selection, flour yield and comprehensive utilization of by-products, involving the following key areas: (1) **efficient grinding technologies**. The standard mandates the use of efficient grinding equipment and processes in wheat flour processing to reduce grain losses during the separation

of bran and endosperm; the number of grinding passes and screening stages should be reasonably set to ensure full extraction of endosperm and reduce residual endosperm in the bran. (2) **Flour yield control**. The specific flour yield rates should be specified, for example, specifying a certain range (e.g., 70%-78%) for the yield of ordinary wheat flour, to maximize the utilization of grain resources; grinding and screening technologies should be optimized at different processing levels to increase both product quality and flour yield, thus preventing waste caused by excessive processing. (3) **Comprehensive utilization of by-products**. Processing by-products such as bran and inferior flour should be collected separately and then used as feed or food additives to prevent direct scrapping; the application of technologies to improve the utilization of by-products is encouraged, so as to turn remaining materials in processing into high value-added products. (4) **Loss and waste monitoring**. A grain loss and waste monitoring mechanism should be established to record and analyze grain losses and waste in real time throughout the chain from raw materials to finished products; equipment should be calibrated and maintained on a regular basis to reduce raw material waste caused by equipment fault. (5) **Energy-saving and environmentally-friendly processes**. Energy-saving processing processes and equipment should be adopted to reduce energy consumption while minimizing losses due to improper temperature and humidity control during processing; enterprises are encouraged to employ intelligent processing systems to improve processing accuracy and minimize losses caused by manual operations.

5. China's Initiatives to Promote the Implementation of Typical Standards for Grain Conservation and Loss Reduction

5.1 Organizing publicity and interpretation activities

First, a multi-platform publicity strategy. The importance of grain conservation and loss reduction and the details of relevant standards have been widely disseminated through various channels such as television, radio, newspapers, and social media. Publicity materials in various forms, such as animations, short videos, and illustrated posters, have been produced using multimedia resources to attract the public and enhance the appeal and coverage of such publicity. Second, online and offline interpretation meetings. Online live programs and offline meetings have been organized, inviting experts, scholars and government officials to interpret and discuss the relevant standards in details. Interactive Q&A sessions have been held to solve the problems the public and enterprises may encounter in practice, thus ensuring that the standards are correctly understood and effectively implemented. Third, cooperation. Publicity and educational campaigns for grain conservation and loss reduction have been organized in partnership with educational institutions, enterprises and non-governmental organizations (NGOs). The networks and resources of these organizations will help instill the concept of

grain conservation and loss reduction in the public to foster a favorable atmosphere of participation by all sectors of society. Fourth, ongoing tracking and feedback. Feedback from all sectors of society on the implementation of grain conservation and loss reduction standards has been collected on a regular basis to evaluate how the publicity and education campaigns work. The publicity strategy has been optimized from time to time based on the feedback to ensure the sustainability and effectiveness of the publicity campaigns.

5.2 Implementing pilot projects for green grain storage standardization

Recommended by provincial food and strategic reserves administrations and China Grain Reserves Group Ltd. Company, the National Food and Strategic Reserves Administration selected 59 grain reserves enterprises across the country as pilot units for green grain storage standardization. Within three years, these pilot units explored work patterns for green grain storage standardization by adopting green grain storage technologies, upgrading facilities and equipment, formulating and revising green grain storage standards, and establishing a green grain storage standards system for enterprises. In the process, they adopted cutting-edge grain storage technologies and management measures to improve grain quality, reduce losses and ensure grain preservation. They reinforced the research and development of green grain storage technologies and the revision of relevant standards to translate scientific and technological achievements into standards in a timely manner and improve the green grain storage standards system. They also summarized scientific and feasible experience in green grain storage management, and facilitated the implementation and improvement of standards in the green grain storage sector. In addition, these pilot units widely publicized the work patterns for green grain storage standardization through various channels, including by promoting green grain storage standards and conducting learning and exchange activities. Based on the implementation of relevant standards, the National Food and Strategic Reserves Administration continues to refine the green grain storage standards system, driving more enterprises to practice green grain storage.

5.2.1 Common approaches to piloting green grain storage standardization

First, facility construction and upgrading. (1) Building and renovating grain silos. Many local governments have been vigorously promoting the construction of modern grain depots above designated size and upgrading and renovation of old ones. In 2023, for example, the storage capacity of new standard grain depots in Guangdong Province increased by 776,000 tonnes year-on-year, and that of upgraded and renovated grain depots increased by 264,000 year-on-year. Linyi, a city in Shandong Province, supported an increase of 50,300 tonnes in the storage capacity of three county-level grain reserve depots through new and expansion projects, and an increase of 95,000 tonnes in the storage capacity of the city-level and seven county-level

grain reserve depots through upgrading and renovation projects. (2) Applying new depot types and technologies. Localities have been guided to adopt depot types that meet local conditions, and apply new technologies for green grain storage. For example, the Phase III project of the central grain depot in Zhongshan, Guangdong Province, featured innovative "double-roof squat silos" to improve the insulation, rainproof and airtight performance of the silos, reduce equipment energy consumption, and minimize dust spillage during the delivery of grains.

Second, storage management optimization. (1) Supporting the pilot units in exploration and innovation. The pilot units have been supported and guided to explore work patterns for green grain storage standardization that can be replicated and extended to other regions. For example, Guangdong Grain Reserve Management Group Co,. Ltd. invested in the upgrading and transformation of a number of grain depots towards scientific and green grain storage technologies, with all these depots covered by temperature control, controlled atmosphere, and intelligent grain depot management. Grain depots subordinate to Guangdong New Co-op Tianrun Grain and Oil Group Co., Ltd. also explored a number of temperature control means to realize 100% coverage for low-temperature and quasi-low-temperature grain storage. (2) Giving play to the leading role of demonstration grain depots. The rating of grain depots has been continuously carried out to encourage ongoing scientific and technological innovation among grain depots, give play to their leading role, and promote an overall improvement in green grain storage.

Third, innovation in grain storage technologies. (1) Promoting the application of green grain storage technologies. For example, Guangxi promoted the construction of high-standard grain silos featuring low-temperature and quasi-low-temperature grain storage and information technologies in grain depots directly under the autonomous region, some leading enterprises, and central grain depots in major countries producing high-quality rice; at the grassroots level, the autonomous region focused on improving the airtightness and insulation of warehouses, and promoting the application of new green grain storage technologies such as temperature control, internal circulation, and controlled atmosphere. (2) Advancing smart grain management. Comprehensive grain management information platforms and enterprise grain depot information systems have been established to achieve fully information-based management. Technologies such as big data and artificial intelligence (AI) have been leveraged to improve early warning systems and raise management efficiency. For example, Guangdong Province developed a comprehensive management information platform for grain and emergency supplies and an enterprise grain depot information system, with more than 500 local grain reserve depots fully covered by information-based management and equipped with grain loss and waste monitoring modules.

Fourth, policy support and guarantee. (1) Financial support. The government has raised funds through various channels, including the fiscal budget, to support the construction of grain storage facilities and the transformation towards green grain storage technologies. For example, Guangxi Province secured 126 million yuan in the regional fiscal budget from 2021 to 2023 to mobilize 88 grain storage facility projects. (2) Institutional guarantee. The relevant administrative measures and regulations have been revised and improved to create a sound system of grain conservation and loss reduction standards, providing institutional guarantee for piloting green grain storage standardization. For example, Wuxi, a city in Jiangsu Province, revised the Administrative Measures for Local Grain and Oil Reserves in Wuxi and the Regulations on the Safety of Grain and Oil Circulation in Wuxi.

Fifth, talent cultivation and exchanges. (1) Introduction of professionals. The introduction of grain storage, logistics, processing and other professionals has been emphasized, providing intellectual support for piloting green grain storage standardization. For example, at a meeting on promoting the pilot projects for green grain storage standardization, Wuxi stressed the importance of talent introduction to meet the needs of the relevant work. (2) Experience sharing and cooperation. Activities such as technical training sessions on green grain storage, meetings for exchange of experience and promotion meetings have been organized to facilitate experience sharing and cooperation. The Standards and Quality Center of the National Food and Strategic Reserves Administration held a mid-term meeting to exchange views on the pilot projects for green grain storage standardization in September 2023. Wuxi Food and Strategic Reserves Bureau organized a meeting on promoting the pilot project for green grain storage standardization to exchange views on related issues and plan for next steps.

Fifth, publicity, education and guidance. (1) Carrying out thematic publicity campaigns. The idea of cherishing and saving grain has been widely disseminated among the public on important occasions such as the World Food Day, the Food Science and Technology Week, and the China Food Safety Publicity Week to increase public awareness and participation in green grain storage. For example, Wuxi continues to organize educational and experience activities themed "combating waste and promoting food security" at sunshine grain silos to further extend grain conservation publicity and education to government organs, schools, enterprises, communities, rural areas, households, the army, and the Internet. (2) Building publicity and education bases. The building of food culture publicity and education bases has been encouraged to display and disseminate food culture and popularize knowledge about grain, and foster a social atmosphere of practicing thrift and combating waste. For example, Linyi has built four provincial and 12 city-level food culture publicity and education bases.

5.2.2 Case study

As a strong champion of the food crop production strategy based on technology application, Zhangjiagang Grain Industry Development Co., Ltd. (hereinafter referred to as the "company") was included in the 2023 list of the units for piloting green grain storage standardization by the National Food and Strategic Reserves Administration. First, the company developed a "digital grain depot system" in partnership with universities and research institutes in the industry. On this basis, it established an "integrated green grain storage system" that incorporates advanced technologies from biogenic protection, intelligent robots that apply pesticides on the surface of grain piles, to multi-parameter grain monitoring and early warning. This enabled standardized and intelligent application of green grain storage technologies. Second, the company developed "native" innovative and practical technologies, including an "intelligent cooling system for low-temperature grain silos", driving "small steps forward" in grassroots grain technology innovations. By applying a combination of technologies, the company rendered the prices of its rice stockpiles sold through online public auctions usually 0.01-0.05 yuan higher than those of similar grains during the same period, thus improving the corporate efficiency. This also enabled Suzhou, the city where the company is located, to secure an around 25% further reduction in grain storage losses on the basis of reaching the national standard, and to become a leader in the industry.