BRIEF

Role of Mechanization in Reducing Food Loss and Waste in China

A Case Study for Grain Crops

ESCAP 75 MOVING FORWARD TOGETHER CSAM

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Executive Summary

Reducing food loss and waste at all stages from farm to plate is a major priority of the global development agenda. Target 12.3 of the Sustainable Development Goals aims to halve per capita global food waste at retail and consumer levels by the year 2030, as well as reduce food losses along the production and supply chains. The Government of the People's Republic of China has accorded importance to reducing food loss and waste. In 2013, it launched the "Clear Your Plate" campaign to reduce food waste and enacted the Anti-Food Waste Law in April 2021.

Rice, wheat and maize account for more than 90 per cent of China's grain output and reducing loss and waste in these crops is crucial. At present, grain loss and waste in the country occurs largely during the production, storage, transportation, processing and consumption stages. The Chinese Academy of Agricultural Sciences estimates the total loss along the entire grain industry chain at about 12 per cent of production (Special Research Group of the Standing Committee of the National People's Congress of China, 2020). Agricultural mechanization offers important and scalable solutions to this issue.

This study examines loss and waste for the main grain crops in China and analyses the role of sustainable agricultural mechanization in its reduction. In particular, it introduces the development of comprehensive mechanization levels of tillage, sowing and harvesting, and their effectiveness in reducing loss. It also lists and explains major mechanization initiatives to reduce grain loss in China, including enhanced technical standard requirements, prioritized research and development, strengthened training for agricultural machinery operators, and holding 'machine operation skill competitions' for operators on mechanized harvesting loss reduction.

This study also examines the role of mechanization in reducing food loss in other Asia-Pacific countries and notes that the region can significantly reduce food loss and waste by improving levels of mechanized harvesting, reducing loss during mechanized harvesting and enhancing capacities for mechanized grain drying. It lists various constraints to reducing grain loss, including inadequate awareness, insufficient financial support, gaps in extension and application of suitable agricultural machinery, uneven machine operation skills, as well as remaining issues related to technical standards.

The following recommendations at both the technical and policy levels are proposed to reduce food loss in China through sustainable agricultural mechanization:

Firstly, promoting extension and application of technologies and machinery for food loss reduction; improving the quality of mechanized precision sowing to enhance the level of mechanized rice planting.

Secondly, formulating improved technical guidance for mechanized precision sowing or precision rice planting by crop and region/area; periodically reviewing and updating technical guidelines for mechanized harvest loss reduction for rice, corn and wheat. These measures can help keep seed usage at a desirable level and reduce harvest loss.

Thirdly, organizing technical training in mechanization techniques for food loss reduction to improve technical skills of machine extensionists at all levels in the industry; ongoing training for regular upgradation of machine operators' skills and promoting mutual learning among operators.

Fourthly, enhancing support for research and development of priority technologies. Upscaling collaboration with financial, and science and technology sectors to strengthen research and development in food loss reduction technologies with increased investments; promoting development of precision seeders as well as low-

loss and high-efficiency harvesters. Stepping up support for research and development of basic manufacturing materiel as well as key components and parts.

Fifthly, progressive augmentation of stipulated requirements for grain loss indicators. Promoting research in grain loss and breakage rate measuring methods; a step-by-step revision of the stipulated seed mechanical damage rate and other indicators. Encouraging agricultural machinery enterprises to improve product quality and helping enhance machine operator performance.

Sixthly, strengthening promotion and supervision of relevant socialized/public services; disseminating information on methods for measuring grain harvest loss rate. National-level enactment of the General Provisions for Socialized Agricultural Machinery Services which should be made available to farmers for access to socialized services and made an important standard and basis for adherence.

Seventhly, implementing targeted financial incentives; enhancing incentives for adoption of machinery and tools that especially help reduce grain loss and waste vis-à-vis other agricultural machinery and tools.

Eighthly, strengthening drying capacity in grain producing areas, including through technical and policy support for construction of grain drying centres; encouraging drying machine manufacturing and grain storage enterprises to collaborate with grain producing and processing entities such as local farmers' cooperatives, to build drying service systems in grain producing areas. Optimizing the planning and design of grain drying service centres; supporting specialized or customized development of grain drying services as well as sharing of services.

Many of these recommendations are also applicable to other Asia-Pacific countries. For instance, it is important to raise awareness about reducing grain loss through advocacy and outreach and strengthen extension and application of loss-reducing technologies and machinery. Adequate training should be provided to improve operator skills. Stronger regional cooperation is needed for the sharing of knowledge and experiences among countries on successful mechanization-based solutions and practices for reducing food loss and waste.

I. Introduction

Reduction of food loss and waste is a major global development priority. Target 12.3 of the Sustainable Development Goals calls for halving per capita global food waste at retail and consumer levels by 2030, as well as reducing food losses along the production and supply chains. The Food and Agriculture Organization of the United Nations (FAO) report State of Food and Agriculture 2019 indicates that food loss and waste (excluding land use change) has a global carbon footprint of 3,300 million tons of carbon dioxide, equivalent to about 7 per cent of the world's total annual greenhouse gas emissions; about 250 km3 of surface and groundwater resources (blue water), accounting for about 6 per cent of total water withdrawals, are used for the production of food that is lost or wasted; and nearly 1.4 billion ha of land, comprising about 30 per cent of the world's agricultural land, are used to grow food that is lost or wasted. Thus, reducing food loss and waste can play an important role in helping improve people's livelihoods, economies and the environment. Reducing food loss and waste can contribute to improved food security in countries, cut down public and private sector expenditure with considerable economic benefits, reduce water consumption, relieve pressure on land and combat climate change.

The Government of the People's Republic of China has made reducing food loss and waste a priority with significant progress. In 2013, China launched the "Clean Your Plate Campaign". China's national plan for the implementation of the 2030 Agenda for Sustainable Development announced in 2016, includes action to halve per capita food waste at retail and consumption levels and reduce food loss during production and supply, by 2030. In April 2021, China adopted a series of additional measures to reduce food loss and waste and enacted the *Anti-food Waste Law*.

China is a major global grain producer and consumer. The 2020 summer season grain and early season rice output was 142.85 billion kg and 27.3 billion kg, respectively, while the output of autumn season grain was 499.35 billion kg. Total grain output in 2020 reached 669.5 billion kg, of which, 211.85 billion kg was rice (an increase of 2.25 billion kg from 2019), 134.25 billion kg was wheat (an increase of 650 million kg from 2019), and 260.67 billion kg was corn (a decrease of 100 million kg from 2019). Summer season grain output reached 145.8 billion kg in 2021, an increase of 2.95 billion kg over 2020.

Food loss and waste in China is mainly in two spheres. One is during production, storage, transportation and processing. Annual loss in storage and transportation is relatively high due to use of simple storage facilities, lack of scientific storage knowledge, insufficient post-harvest drying capacity, ageing storage facilities with suboptimal layout, low levels of standardized transportation, inadequate rural logistics equipment, and unscientific transportation methods, among others. There are also large food losses due to excessive processing, inadequate utilization of by-products and outdated processing technologies. Food losses during storage, transportation and processing amount to 35 billion kg annually. Loss during consumption is mainly in three areas, including commercial and family catering and in public canteens. The annual food waste in urban catering alone is approximately between 17 billion and 18 billion kg (excluding food waste in household diet). The main causes of food waste include unscientific consumer psychology and behavior, inappropriate food management practices and inadequate awareness of the need to save.

According to estimates by the Chinese Academy of Agricultural Sciences, the total loss along the entire food industry chain in China is about 12 per cent (Special Research Group of the Standing Committee of the National People's Congress of China, 2020).

China's food industry has been running special projects for several years on scientific food storage for farmer households. These include the “Food Security Project”, construction of “Smart Grain Depots”, in-bulk transportation of unprocessed foodgrain, moderate food processing and quality food engineering. Significant progress has been made in reducing food loss during grain purchase, storage, transportation, processing and consumption.

The major food loss and waste reduction measures in China are outlined below:

Firstly, close attention was paid during grain purchase to address the problem for farmers in grain storage. Secondly, importance was given to the use of storage and transportation loss-reduction technologies to save food and ensure quality. Thirdly, attention was paid to ensure the use of appropriate-scale processing and comprehensive use of loss-reduction technologies. Fourthly, publicity and education on reducing foodgrain loss, nutrition as well as public health was enhanced. Finally, to reduce food loss across the entire food value chain, legislation and regulation to consolidate the legal basis for reducing post-harvest grain loss was strengthened (National Food and Strategic Reserves Administration, 2021).

This study focuses on how agricultural mechanization has helped sustainably reduce food loss in China, the challenges this faces and makes recommendations for mechanization to further reduce food loss in the country in the future. It also undertakes a brief comparative discussion in relation to the rest of the Asia-Pacific region.

II. How mechanization has helped China reduce food loss during production in a sustainable way

Mechanization has played an important role in transforming agricultural production in China and improving rural productivity and is a critical element in implementing the national Rural Revitalization strategy. It has reduced the burden of farm activities, allowing more rural people to work in cities and improve their income while increasing the incomes of cooperatives and operators. It has also been effective in increasing grain output while reducing grain loss and has supported socio-economic development and social stability. Reduced grain loss through mechanization-based solutions implies more efficient use of land, fertilizers, pesticides and other farming resources in order to meet food demand, which in turn eases the load on land and offers environmental benefits such as reduced pollution and greenhouse gas emissions.

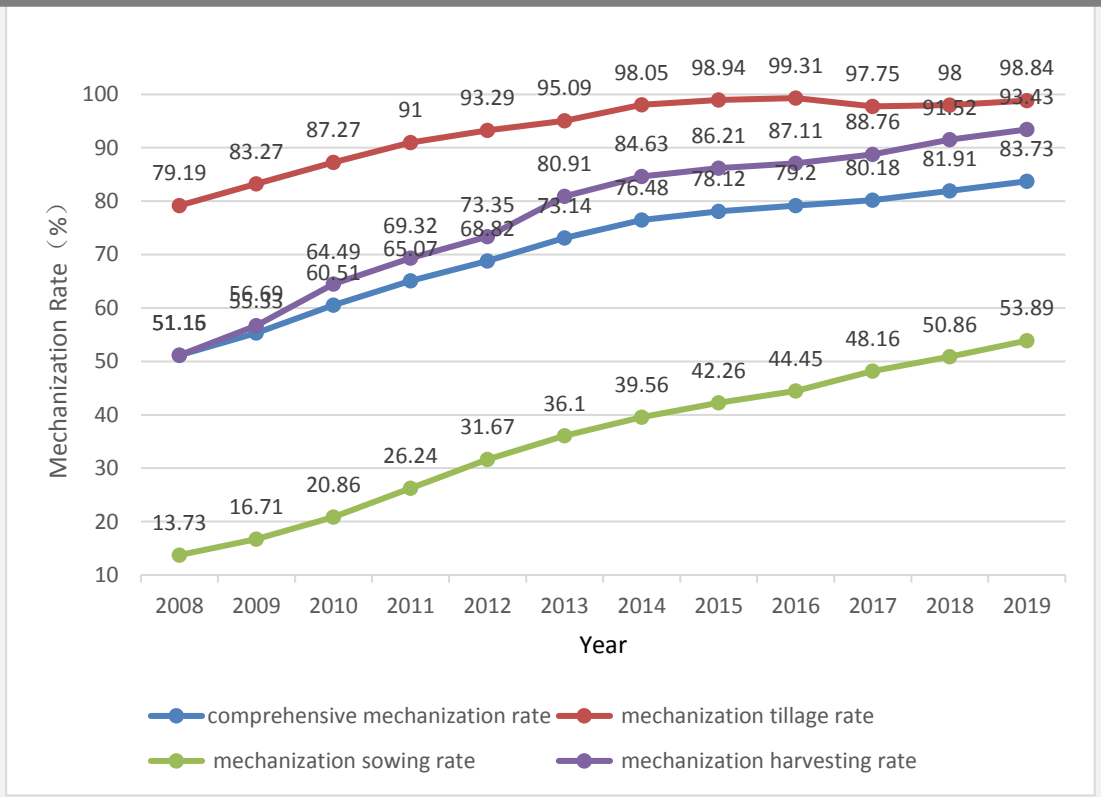
A. Comprehensive mechanization for main grain crops in China and its effect on loss reduction

Grain loss in the production stage occurs mainly during sowing, harvesting and drying. Low germination rate of seeds, low quality of sowing machinery, poor operation techniques, inappropriate sowing date and overuse of seed with the traditional planting method are major factors in the loss of billions of kilograms of grain annually. During harvesting, outdated farmland infrastructure, unsuitable time of harvesting and improper operation of harvesting machinery are among the major causes of loss with the loss rate of manual harvest being about 10 per cent. As much as 5 per cent of the grain is also lost every year due to mildew and germination caused when grains retain excessive water or moisture in a damp environment.

Agricultural mechanization has increased in China over the years, supported by a series of policies promoting the dissemination of agricultural machinery, reducing manpower constraints on farmland. Growth trends, from 2008 to 2019, of mechanical tillage, mechanical sowing, mechanical harvesting and comprehensive mechanization for rice, wheat and corn, are shown in Figures 1, 2 and 3, respectively. Overall, the rates of growth of mechanical tillage, mechanical sowing, mechanical harvesting and comprehensive mechanization have increased significantly. Furthermore, in 2020, the comprehensive mechanization rate for wheat was stable at over 95 per cent. The comprehensive mechanization rates for rice and corn exceeded 85 and 90 per cent, respectively, increasing about 2 per cent, respectively, compared with 2019. The overall comprehensive mechanization rate for crops nationwide reached 71 per cent, an increase of 1 per cent over 2019.

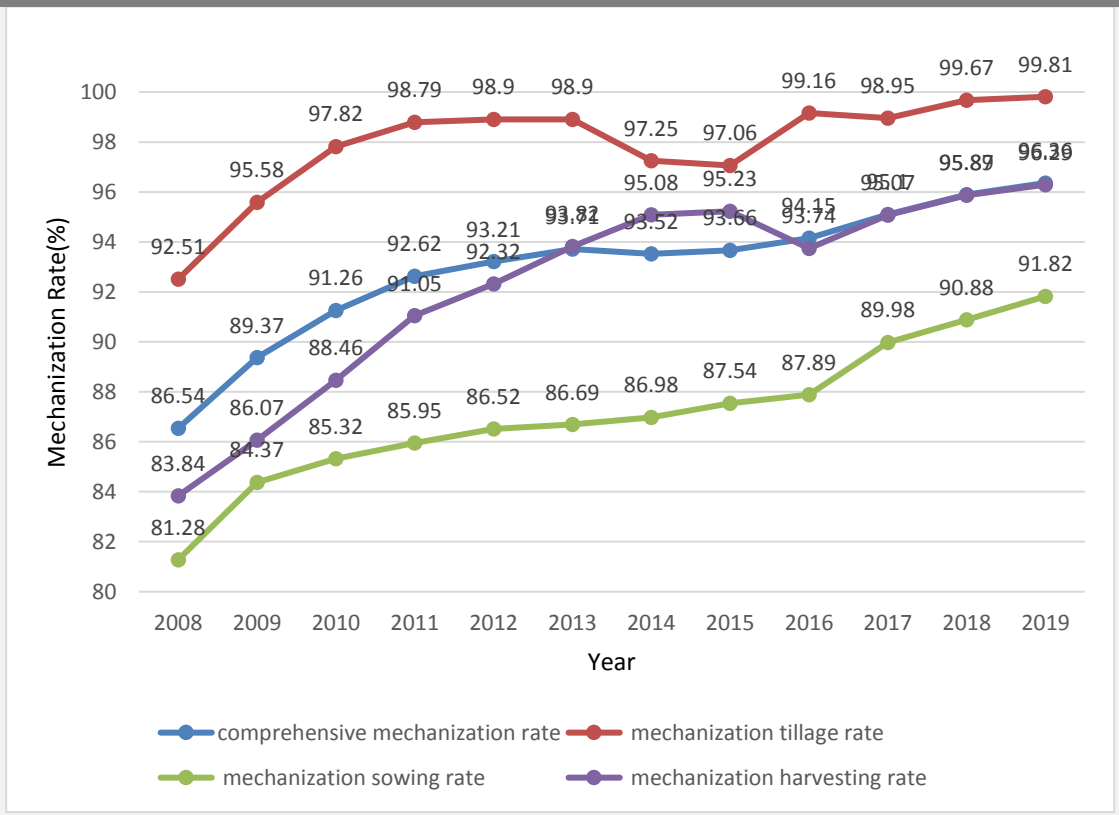
Improvements in agricultural mechanization, especially in planting, harvesting and drying operations, have greatly reduced grain loss in China. According to a preliminary survey, in recent years, excluding exceptional circumstances, average grain loss in mechanized wheat harvesting is about 3 per cent in Huang-Huai-Hai region (including Beijing, Tianjin and Shandong provinces, most of Hebei and Henan

Figure 1 Rate of Mechanization of Tillage, Sowing and Harvesting and Comprehensive Mechanization of Rice in China from 2008 to 2019



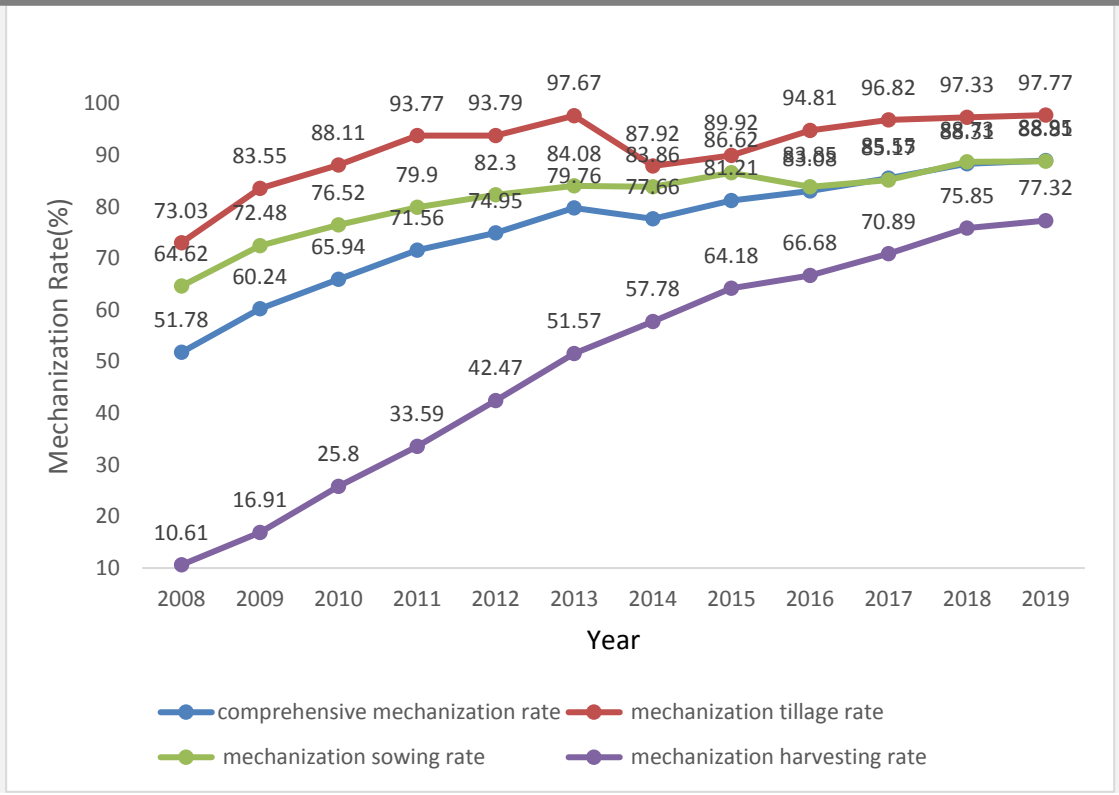
Data source: Annual Reports of Agricultural Mechanization Statistics of China (2008-2019)

Figure 2 Rate of Mechanization of Tillage, Sowing and Harvesting and Comprehensive Mechanization of Wheat in China from 2008 to 2019



Data source: Annual Reports of Agricultural Mechanization Statistics of China (2008-2019)

Figure 3 Rate of Mechanization of Tillage, Sowing and Harvesting and Comprehensive Mechanization of Maize in China from 2008 to 2019



Data source: Annual Reports of Agricultural Mechanization Statistics of China (2008-2019)

provinces as well as Huaibei region of Jiangsu and Anhui provinces, which are the major summer grain-producing areas of China). In recent years, the average grain loss in mechanized rice harvesting nationwide is estimated at about 4 per cent while in mechanized corn harvesting it is about 5 per cent.

In 2021, a series of measures were introduced to reduce food loss related to mechanized harvesting, and initial effects have become visible. Results of 40 'mechanized wheat harvesting tournaments' held in Huang-Huai-Hai region in the summer in 2021 showed a weighted average loss rate of 0.85 per cent. Out of 1,380 plots in the main wheat production counties, 75.6 per cent were found to have a rate of loss of less than 1.2 per cent related to mechanized harvesting and 19 per cent had a rate of loss of between 1.2 and 2 per cent. The remaining 5.4 per cent plots had a higher rate of loss of more than 2 per cent, mainly due to the use of old machinery, late harvesting, over-ripening, lodging and unskilled machine operators.

The actual estimation report covering the main production provinces shows the average rate of loss during mechanized wheat harvesting in the Huang-Huai-Hai region to be controlled within 2 per cent, about 1 per cent lower than the preceding year. A 1-per cent reduction of loss during mechanized wheat harvesting can save 1.25 billion kg of grain, equivalent to saving 200,000 ha of planting area. Official statistics on the mechanized harvesting loss rate for the early season rice in 2021 were not available as of the time of writing of this study but the estimated loss rate is forecast to be 1 per cent lower than that of the previous year.

B. Major mechanization measures in China for food loss reduction

Enhancement of standards

In recent years, the total loss rate index value in

harvesting machinery product standard has become more rigorous in China. The Technical Conditions for Full-feed Combine Harvester (JB/T 5117-2017) were amended in 2017 to reduce the loss rate of rice harvester from 3 to less than 2.8 per cent, and that of wheat harvester to less than 1.2 per cent. The newly amended standard of Corn Harvester (GB/T 21962-2020) has reduced the index of total loss rate of corn ear from 4 to less than 3.5 per cent and that of corn kernel from 5 to less than 4 per cent. The indices in national or industry standards, which take into account the entire industry, have a relatively less stringent value, which is the minimum industry requirement. In actual practice, internal control standards in most enterprises are stricter than the set value.

Research and development to address key bottlenecks

Scientific research and development has been prioritized by the government and the agricultural machinery industry. In particular, state support has been increased for projects along with funding for the agricultural machinery industry from the National Agricultural Machinery Equipment Key Innovation Research and Development Plan and other scientific research projects. Relevant enterprises have also stepped up research and development in seed saving, efficient and low-loss harvesting and drying machinery. Studies have been conducted in technologies for high-speed, precision seeding and transplanting as well as for large-scale, intelligent and efficient grain harvesting. Studies on threshing and cleaning devices of harvesting machinery have been conducted to improve threshing quality and cleaning efficiency and reduce loss and impurity rates. Grain drying technologies such as online moisture measurement, vacuum low-temperature drying, hot air vacuum double-effect drying, infrared vacuum combination drying, solar grain drying, Programmable Logic Controller (PLC) control, multi-fuel system development, and thermal efficiency improvement of moulding biomass fuel hot blast stove, have also been investigated.

Improving machine operation skills

Agricultural machinery operator skill is an important factor in reducing food loss and waste. Government training has been organized to enhance operator awareness of loss reduction and mastery of loss reduction techniques, machine operation and maintenance. The training was funded by the High-Quality Farmers' Training Programme and other projects for nurturing professional agricultural machine operation skills. Competitions in machine operation skills to reduce food loss were also organized for agricultural machinery operators. Moreover, agricultural machinery-related enterprises organize machine operation and maintenance training and demonstrations for customers.

III. Role of mechanization in reducing food loss in other Asia-Pacific countries – a comparative assessment

Food loss and waste levels differ in developed and developing countries. In Australia, Canada, Europe and the United States of America, more than half of food loss and waste is at the consumption stage. In developing countries, two-thirds of food loss and waste is during collection and storage, due to inadequate harvesting and storage machinery and infrastructure (World Resources Institute, 2013). It is evident that efficient grain production and processing are closely linked to mechanization.

In the Asia-Pacific region, Japan, a developed country, has achieved whole process mechanization of rice and the entire process of rice harvesting in the country is mechanized. The main machine used is the half-feed type harvester, followed by the full-feed type, which can reduce food loss during harvesting, while the cutter-rower is rarely used. The degree of mechanization of rice drying in Japan has reached 95 per cent. Specialized rice dryers are used to avoid losses caused by dampness and mildew. However, in China, mechanized rice drying is still at a relatively low level and drying capacity is inadequate in grain producing areas. In India, rice and wheat account for the bulk of post-production grain loss. The state of Karnataka, one of India's top ten food production areas, has a high level of loss and waste during rice and wheat processing. A comprehensive expert evaluation of food loss and waste, considering various social and economic aspects, has proposed improving productivity through education and training in post-harvest treatment skills for farmers, especially women (Basavaraja and others, 2007). In Myanmar, a major constraint on rice production is the low degree of mechanization. Post-harvest losses can be much higher with conventional operations compared to mechanized systems. For example, in the rice-legume farming system in Myanmar's Irrawaddy Delta, monsoon rice is harvested manually and the crop is left stacked on the field or embankment for up to four weeks until labour and equipment are available for threshing. Delayed threshing results in the harvested crop being damaged by fragmentation, birds and rodents and losing quality due to discolouration, mildew and broken grain. By studying the impact of the transition from traditional to improved post-harvest operations on income, energy efficiency and greenhouse gas emissions in smallholder rice fields in the Irrawaddy Delta, experts have estimated that mechanized practices can increase net income by 30-50 per cent compared to traditional methods. Despite the additional energy used in machine manufacture and fuel consumption, mechanization significantly reduced post-harvest losses and did not increase the total life cycle energy or greenhouse gases. Combine harvesting helped to significantly reduce harvest loss by 3-7 per cent by weight, the study found. The use of dryers and sealed storage reduced discolouration by 3-4 per cent and increased the recovery rate of whole grains by 20-30 per cent by weight (Gummert and others, 2020).

A comparative analysis among these countries suggests that increased mechanization of harvesting, reduced mechanization-related loss and increased mechanization of drying could significantly reduce food loss and waste in countries in the region having relatively lower levels of mechanization, while also freeing human power and increasing farmers' incomes.

IV. Challenges to mechanization for reducing food loss in China

Although the loss-reduction capacity of mechanized harvesting of main grain crops in China has gradually improved and loss rates of harvesting machinery are above the basic standard, some factors still affect loss-reduction performance. These are mainly related to awareness of loss reduction, financial support, extension, machine operation and standards requirements.

A. Inadequate awareness of loss reduction

Reduction of food loss is a priority for the Government of China which has adopted a series of measures, increased publicity and training as well as technical guidance in recent years. However, in the field, cooperative managers, machine operators and farmers, at times lack sufficient awareness of reducing grain loss and have inadequate understanding that reduction of loss is equivalent to increased yields. The economic, social and ecological benefits of reducing food loss are not yet fully recognized.

B. Insufficient financial support

During the 13th Five-Year Plan, the government allocated funding for scientific research and development on agricultural machinery and equipment through specific projects but it was insufficient. There is need to step up research on basic materiel and key machinery such as precision seeders and low-loss, higher efficiency harvesters. Research and development in key technologies such as low-loss threshing, flexible threshing, intelligent loss monitoring and adaptive control, needs major improvement. Moreover, the level of subsidies for rice trans-planters, precision seeders and other grain loss-reduction machinery is the same as that for ordinary agricultural machinery.

C. Gaps in extension

Although the overall level of agricultural mechanization in China is increasing, extension and application for machinery and equipment directly related to food loss and waste reduction is uneven. For example, extension and application for rice trans-planters, precision seeders, seed-coating machinery, pharmaceutical seed-mixing machinery and other seed-saving machinery, needs to be strengthened. The application of high efficiency and low-loss harvesting machinery requires to be extended further and mechanized drying capacity enhanced.

D. Uneven machine operation skills

Every year, new machine operators enter the industry, resulting in uneven operational skill levels. Unskilled operators have difficulty in harvesting over-mature grain, harvesting on rainy days and working in special operating environments such as in lodging and mud. Some operators also run machines at high speed in order to earn more income and exceed the normal operational speed range of the machine. The supporting power and operation speed of some models does not match the feeding amount, increasing the rate of loss.

E. Remaining issues related to standards

Because the loss rate index in the harvester product standard is usually measured under ideal test conditions, the loss rate value of the product during testing is usually lower than during actual operation. For example, while the product standard of the full-feed wheat combine states that the total loss rate is required to be less than 1.2 per cent, the actual operating loss rate is 2-3 per cent. It is, therefore, necessary to not only study whether the harvester standard index has room for a stricter value, but also to find ways to optimize test conditions and methods so that stricter standard requirements can drive reduction in the harvester loss rate.

V. Recommendations

It is important to enhance production practices of rice, corn and wheat through mechanized loss reduction technical guidelines and policy support for all segments of the food production process including cultivation, plant protection, harvesting, drying, storage and transport, as well as through the establishment of a standardized production system. Technical guidance and policy support need to be synergized collectively by the government, agricultural machinery manufacturers, farm enterprises, and other entities such as agricultural producers and operators, and agricultural machinery cooperatives.

A. Technical measures

Enhancing extension and application of mechanized loss-reduction technologies and equipment

The quality of mechanized precision sowing should be improved by forging a 'high-quality commercial seeds + high-performance precision seeding machine' joint mechanism. It is also important to accelerate the pace of extension and application of seed-coating and pharmaceutical seed-mixing machinery and promote extension of key technologies such as pharmaceutical seed-dressing. Mechanized rice planting should be improved. Priority should be given to technical demonstration activities in the southern rice growing region, strengthening field technical guidance, promoting standardized and centralized seedling-raising technology, supporting development of seedling-raising factories/facilities and reducing manual rice seeding and broadcasting.

Formulating and publicizing technical guidance

Technical guidelines on mechanized precision sowing or rice precision planting should be formulated by crop and region/area, drawing upon the Expert Group on Whole Process Mechanization to Promote Crop Production led by the Ministry of Agriculture and Rural Affairs, China. Technical guidance to reduce loss from the mechanized harvesting of rice, corn and wheat should be periodically reviewed and revised. The government can provide guidance for standardized operating instructions which can be further elaborated and quantified in accordance with local agricultural systems, production habits and farming seasons. Operators and farmers should also be supported to apply such standardized operating instructions to reduce harvesting loss and seed usage.

Continuing enhancement of machine operator performance

Efforts should be made for continual improvement of machine operators' skills. Ongoing training of technical extensionists should be carried out to strengthen their knowledge of mechanized food loss-reduction technologies. Prioritizing food loss reduction in the main food-producing counties, annual training can be organized for machine operators with the help of agricultural mechanization technology extension agencies at all levels as well as cooperatives and other private institutions. There is also a need to promote sharing of experiences and mutual learning among machine operators.

Scientific research on key technical constraints

Scientific research should focus on improving the development of precision seeder and low-loss, high-efficiency harvesters and manufacturing standards and quality of domestically-produced agricultural machinery. Research and development should also focus on manufacturing materiel such as ditching disk, seed row disk and finger clip spring of no-tillage precision seeder as well as other manufacturing materiel like conveyor belts and rubber tracks of harvesters. In the area

of core components, emphasis should be on supporting research and development of hydraulic motors, reversing shunt valves and other key parts. In core technologies, emphasis is needed on low-loss threshing, flexible threshing, and intelligent loss-monitoring and adaptive control. Research on basic core technologies such as precision seed arrangement, low-loss seed cleaning and self-cleaning, high cleanliness impurity removal, and precision clamping and emasculation technology should also be strengthened.

Progressive improvement of grain loss reduction index

It is necessary to closely follow up on the production and application of agricultural machinery by studying measurement methods of the grain harvest loss and breakage rates, and with explicit definitions/descriptions of standard operational procedures of the grain combine harvester test method. Food production losses can be reduced through improved science-based interventions, normalization and operability of testing, and gradually revising the stipulated seed mechanical damage rate, total harvest loss rate, drying damage rate and other indicators. Agricultural machinery manufacturing enterprises need to be encouraged to constantly improve product quality and agricultural machinery users to improve the quality of operations.

B. Policy measures

Enhanced publicity and supervision of socialized/public services

To help famers and operators reduce food loss and waste, it is necessary to change existing mindsets by disseminating information on methods to measure grain harvest loss rates. The General Provisions for Socialized Agricultural Machinery Services should be enacted at the national level and made available to farmers for accessing socialized services and used as an important standard.

Augmented support for research and development in priority technologies

In conjunction with the financial and science and technology sectors, research and development on grain-saving and loss-reduction technologies should be intensified, funding support for scientific research increased and a high-quality, efficient and safe technology and supply system set up for the entire grain industry chain. Full support should be provided from the major scientific research projects such as the National Key Innovation and Research and Development Program for Agricultural Machinery Equipment. Research on basic materiel and key components and technologies for agricultural machinery should be encouraged, intelligent and precision equipment for grain operations developed, and grain loss-reduction technology development promoted.

Targeted financial incentives

Increased financial support is needed for machinery and tools that help reduce grain loss and waste. For example, for the purpose of financial support, preferential treatment can be given to rice trans-planters, and a technical distinction made for the discharge device of precision seeders so that the finger clip seeder that ensures precision seeding can be classified separately. For advanced or intelligent no-tillage seeders, structural parameters can be added in the classification or it can be classified separately. Subsidies for machines and tools with relatively outdated seeding technological parameters can be gradually reduced or withdrawn.

Improving grain drying capacity in production areas

Local government assistance for the construction of drying centres should be strengthened. The channels of support should be broadened with a focus on key rice and corn production counties and the improvement of grain drying capacity in less developed areas should be promoted.

Enterprises manufacturing drying machines and grain-storage facilities should be encouraged to join hands with grain producing and operating entities such as local cooperatives, in building drying service systems in grain production areas. Grain drying service centre layout should be optimized to improve efficiency. Specialization of grain drying services and sharing of drying services should be promoted while strengthening the link between smallholder farmers and modern agricultural operations.

In terms of recommendations for the Asia-Pacific region, synergy should be promoted among the public and private sectors, including governments, research institutions, enterprises and agricultural producers, to reduce food loss and waste. The following four suggestions can help enhance the role of mechanization in reducing food loss and waste.

Firstly, it is important to raise farmer and public awareness of the importance of reducing food loss, including recognition that reduction in loss amounts to an increase in production. Secondly, extension and application of grain loss-reduction machinery and technologies with a focus on precision sowing, high efficiency and low-loss operations, and drying machinery, should be promoted more vigorously. Thirdly, vocational skills training can improve the ability of agricultural machinery operators to operate advanced equipment. Finally, regional cooperation among countries in the Asia-Pacific region should be enhanced through establishing or strengthening regional coordination mechanisms for sharing successful experiences on mechanization-based food loss and waste reduction.

References

Basavaraja H, and others (2007). Economic Analysis of Post-harvest Losses in Food Grains in India. *Agricultural Economics Research Review.*20(6):117-126.

Gummert M, and others (2020). Assessment of post-harvest losses and carbon footprint in intensive lowland rice production in Myanmar. *Scientific Reports.* 10(1):19797-19797.

National Food and Strategic Reserves Administration (2021). *A news conference on food saving and loss reduction in the field of food circulation.* Available at http://www.scio.gov.cn/m/xwfbh/gbwxwfbh/xwfbh/lsj/Document/1705020/1705020.htm

Special Research Group of the Standing Committee of the National People's Congress of China (2020). *Research report on the situation of cherishing food and opposing waste.* Available at http://www.npc.gov.cn/npc/c30834/202012/54c3e0f5e7e94ecab9feb5cf9f522f25.shtml

World Resources Institute (2013). *Reducing food loss and waste.* Washington, DC. Available at https://www.unep.org/news-and-stories/press-release/cutting-food-loss-and-waste-will-benefit-people-and-environment-says

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