中国农产品初加工机械化发展与实践

Post-harvesting and processing mechanization of Agricultural Products in China

Reporter: Qizhen Xie, Professor
Academy of Agricultural Planning and Engineering, MARA
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1. Aim of primary processing mechanization
2. Present situation of mechanization of grain and oil primary processing in China
3. National Policy for supporting primary processing
First Part

Aim of primary processing mechanization
1. Concept and scope of agricultural products

- **Agricultural Products**
  
  Refers to the primary products from planting, *forestry*, animal husbandry and fishery.

- **Classification of Agricultural Products**

  1. **planting Products**

  2. **animal husbandry products**

  3. **fishery products**: Fish, shellfish, shrimp, algae, etc.

  - **Grain**, e.g. wheat, rice, corn, bean, potato
  - **Oil seed**, e.g. rapeseed, peanut, oil sunflower, etc.
  - **Fruit**, e.g. apple, orange, banana, pear, and etc
  - **Vegetables**, including root, stem, flower, leaf and fruit vegetables
  - **Characteristic products**, e.g. cotton, tea, cocoon, tobacco

  - **Meat**
  - **Egg**
  - **Milk**
2. Primary processing machinery for agricultural products

The primary processing of agricultural products refers to the one-time processing of agricultural products that does not involve the change of the internal components of agricultural products.

One of five industries

- Planting machinery
- Animal husbandry and breeding machinery
- Fishery machinery
- Agricultural products primary processing machinery
- Agricultural power machinery

8 major categories and 15 minor categories, It includes 89 items.

1. Seed processing machinery
2. Grain, Oilseed, sugar machinery
3. Cotton, hemp, silkworm machinery
4. Fruit, Vegetable, Tea machinery
5. Herbs, spices, tobacco machinery
6. Natural rubber machinery
7. Animal husbandry and breeding machinery
8. Fishery machinery
3. Aim for developing agricultural products processing mechanization

(1) To reduce the postharvest losses of agricultural products can ensure the supply security.

In 2022, China produced

Grain 686 million ton
Oilseed 36 million ton

According to statistics, the losses among storage, process and transformation is 35 million ton, is 5% of total output.

(2) To promote farmers' income and rural economic development.

- Reducing losses means increasing income.
  - e.g. reduce grain loss of 1 million tons, means 3 billion RMB Yuan.

- Generate value-added income by storing off-peak sales
  - e.g. Extend storage time through modern storage facilities, and earn income by selling in off-season,

- To produce high-value products by primary processing, can increase farmers income.
  - e.g. prolongs processing chain and improves the commodity value.
    Paddy-rice, wheat-flour

➢
Aim for developing agricultural products processing mechanization

(3) Conducive to saving land and avoiding waste of resources

- Corn loss: 10 million tons
- Corn cultivated land: 2 million ha

(4) Reduce pollution and protect ecological environment.

- Rot and deteriorate, pollute the environment
- Increase the amount of domestic garbage
- Pollute the water source.

(5) Ensure the quality of agricultural products and eliminate potential food safety hazards.

- Corn is mildewed and produces aflatoxin.
- Accumulation of harmful microorganisms
- Mosquito and fly-borne diseases

Reducing losses means saving cultivated land!!
The 2nd part

Present situation of mechanization of grain and oil primary processing in China
1. The overall situation of China's grain and oil primary processing mechanization development.

- **Development level of mechanization of primary processing of grain and oil**

  \[ A = 0.35A_1 + 0.35A_2 + 0.30A_3 \]

  - \( A \) — Mechanization rate of primary processing of grain and oil
  - \( A_1 \) — Mechanization rate of grain and oil threshing
  - \( A_2 \) — Mechanization rate of grain and oil cleaning
  - \( A_3 \) — Mechanization rate of grain and oil quality guarantee (drying + storage)

  For grain: \( A = 65.75\% \) \( A_3 = 27.5\% \)
  For oilseed: \( A = 57.73\% \) \( A_3 = 26\% \)

- **Ownership of grain and oil primary processing machinery**

  - Grain primary processing machinery: 12.51 million sets
  - Drying equipment: 145 thousands sets
  - Oil seed primary processing machinery: 807.2 thousands sets

\[ A_1 = \frac{X}{Y} \times 100\% \]

- \( X \) — grain mass which is threshed by machinery.
- \( Y \) — total grain mass which is threshed by any ways.
2. Equipment manufacturing popularizing evaluating

- **Manufacturing situation of grain drying equipment**:

There are more than 400 grain and oil processing machinery enterprises in China, and 205 grain dryer manufacturers.

- **Complete system for Equipment performance testing, popularizing & evaluating**

- **Complete standard system**

- **Complete Science & technology R&D system**
3、 应用粮食和油料初级加工机械

主粮食和油料初级加工流程

| 粮食 | 去皮、脱粒、清洁、分级、干燥、储藏、粉碎和磨制。
| 饱和 | 脱壳、清洁、分级、干燥、储藏和榨制。

粮食干燥机

干燥部分是粮食和油料最薄弱的环节

- 批量式
- 循环式
- 顺流式
- 逆流式
- 横流式
- 混流式
- 组合式

Grain dryer

continuous
3. Application of grain and oil primary processing machinery

- Peeling machinery - for corn
- Threshing machinery
  - Simple thresher
  - Compound thresher
- Cleaning machinery
  - Double-cylinder cleaner
  - Combined cleaner
  - Vibrating Cleaner
3. Application of grain and oil primary processing machinery

- Corn drying in the sun
drying in the sun
and ventilation with natural air
3、 Application of grain and oil primary processing machinery

- **Wheat /Rice**
- **Pennut /rapeseed**
3. Application of grain and oil primary processing machinery

(2) Batch type grain dryer

- **Stacked Batch type grain dryer**

**Features:**
- Simple structure, Low price.
- Wide application, all kinds of agri. Products
- Lower capacity, low efficiency, Loading and discharging by hand

- Single bed batch dryer
- Multi-beds batch dryer
- Stacked corn ear drying chamber with slopping bed
3. Application of grain and oil primary processing machinery

(2) Batch type grain dryer

- Cyclical dryer
  - The largest amount dryer, about 85% in all dryers
  - The largest amount of manufacturers

Features:
- Specific for paddy, also dry wheat and corn (maize)
- Low drying temp. cyclical drying technology, drying and tempering Alternately, good quality, lower drying rate, 0.5%-1.0%/h.
- Capacity ≤ 30t/batch
- Good flexibility for different capacity, Tandem arrangement or Parallel arrangement
3. Application of grain and oil primary processing machinery

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Cyclical dryer with Cross-flow drying tech.

Cyclical dryer with Mix-flow drying tech.
3. Application of grain and oil primary processing machinery

（3）Continuous grain dryer

**Features:**

a. Continuous drying, no cyclical operation;
b. Mainly for corn and wheat, need to modify structure for paddy;
c. High drying efficiency, capacity, 1000t/day, 1500 t/day,
3. Application of grain and oil primary processing machinery

(3) Continuous grain dryer

- Crossflow dryer

**Features:**
- simple structure, convenient manufacture and low cost.
- grain flow direction is perpendicular to the hot air flow direction.
- Shortcomings
  - Uneven drying, on the inlet side the grain too dry, on the exhaust side grain is not dry enough, energy consumption is high.
3、Application of grain and oil primary processing machinery

（3）Continuous grain dryer

- Concurrent flow dryer

Features:
- Hot air flows in the same direction as grain;
- Fast drying speed
  Use higher hot air temp., such as 200 ~ 285℃, grain temp. not too high,
- Low energy consumption, and high efficiency.
- Uniform drying and good grain quality;
- Thicker grain layer, larger resistance of grain to airflow, and larger fan power
- Suitable for drying high moisture grain.
3、Application of grain and oil primary processing machinery

（3）Continuous grain dryer

- Mixed flow dryer

Features:
- Mixed-flow drying technology alternately arranged the inlet and exhaust air ducts, and grain flow downwards according to the S-shaped trail, and alternately contact high-temp. and low-temp. airflow, more high air temperature than cross-flow dryer.
- Dry small grain and oilseed, such as rapeseed.
- Lower power than concurrent flow dryer.
- High efficiency and capacity
- Better grain quality, lower crack rate and thermal damage.
3. Application of grain and oil primary processing machinery

(4) Heat Pump Grain Dryer

<table>
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<tr>
<th>High quality</th>
<th>High efficient</th>
<th>Energy-saving, clean energy</th>
<th>Cost-effective</th>
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| • Less circulation times than traditional dryers, drying temp. is below 55 °C  
• Fit for seed drying | • In Guangdong province, 16h for drying early rice and 20h for late rice  
• Drying time is less 30% than other dryers | • Drying cost 40RMB/t wet paddy, lower 40% than biomass fuel, lower 70% than diesel.  
• no carbon dioxide emissions | • Profit can be achieved in the drying process.  
• The investment return period is 7 years. |
3. Application of grain and oil primary processing machinery

(5) Self-circulating intelligent drying and storage integrated silo

- Intelligent grain storage facility combining natural ventilation with mechanical ventilation
  Capacity 100t-300t, fit for smaller farmers with 20-30ha. Carry out integration of grain drying and storage;
- Smaller area to build, longer operation time, and farmers can get bonus by storage;
- Low drying cost and good grain quality.
3. Application of grain and oil primary processing machinery

(6) Complete sets of Grain Drying

The main facilities and auxiliary facilities and equipment for wet grain weighing, cleaning, drying and temporary storage. Generally, it includes complete sets of equipment such as weighing, cleaning, temporary storage and drying.
3. Application of grain and oil primary processing machinery

Auxiliary equipment of complete grain drying equipment:
- Motor truck scale
- Grain cleaner
- Bucket elevator
- Horizontal belt conveyor
- Inclined belt conveyor
- Bag-type dust remover

Temporary storage silo before and after drying
3、 Application of grain and oil primary processing machinery

（5）Mobile grain dryer
3. Application of grain and oil primary processing machinery

- Heat source is used for grain drying.

Coal-fired hot air furnace

Diesel/natural gas-fired hot air furnace

Biomass bullet hot air furnace

Heat pump
### Classification of grain storage facilities

- According to the shape of the warehouse
  - Bulk bin, packaging bin
  - House warehouse, silo, building warehouse
- According to the warehouse building conditions and equipment configuration
  - Simple granary, general granary, mechanized granary and assembled granary
- According to the location of granary construction
  - Above-ground, underground and semi-underground
- According to the grain storage performance
  - Controlled atmosphere, low temperature, quasi-low temperature and normal temperature
4. Development status of grain storage facilities

(2) Steel Silo

(3) High flat warehouse
3、Typical grain storage technology

Vertical ventilation system

Horizontal ventilation system

4、Development status of grain storage facilities
4. Development status of grain storage facilities

3. Typical grain storage technology

--- Low temperature grain storage technology

**分类**

Low temperature grain storage means that the average grain temperature is kept at 15℃ and below all the year round, and the local maximum grain temperature does not exceed 20℃.

Quasi-low temperature grain storage means that the average grain temperature is kept at 20℃ and below all the year round, and the local maximum grain temperature does not exceed 25℃.

**功能**

Insecticidal and bacteriostatic, inhibit grain respiration, reduce grain dry matter loss, reduce the use of chemical agents, delay grain aging, and ensure grain edible quality and nutritional quality.

**实现**

- Air conditioner control technology controls and adjusts the warehouse temperature, grain temperature and humidity, suitable for high temperature and high humidity areas in the south.

- Internal circulation temperature control In winter, uses the ventilation equipment installed in the warehouse to cool the grain pile temperature, and suitable for the northern region.
4. **Development status of grain storage facilities**

3. **Typical grain storage technology**

   **Modified atmosphere grain storage technology**

   artificially modifies the gas composition or proportion in the grain pile to a certain concentration, and maintain it for a certain time, so as to achieve the purpose of killing insects, inhibiting mold and delaying the change of grain quality.

   Nitrogen storage: Using nitrogen concentration above 95% can effectively delay the change of grain quality.

   - 1. Reduce or eliminate pests
   - 2. Prevent mildew: make the oxygen concentration lower than that required for mold metabolism.
   - 3. Prolong grain storage time: slow down the metabolic activity of stored grain cells and reduce volatilization and oxidation reactions
   - 4. Preserve grain nutrients effectively
   - 5. Save Energy Consumption
5. Production Lion of grain and oil primary processing

(1) Corn processing production line

System composition diagram | 5t/d production line | 20-30t/d production line | 100-120t/d production line
5. Production Lion of grain and oil primary processing

(2) Rice processing production line —— From Paddy to Rice

- 15t/d complete sets of rice milling
- 50-80t/d complete sets of rice milling
- 120-150t/d complete sets of rice milling
- 200t/d complete sets of rice milling
5. Production Lion of grain and oil primary processing

(3) wheat processing production line

- 0-1t/d wheat milling complete set
- 30t/d wheat milling complete set
- 80-100t/d wheat milling complete set
- 200t/d wheat milling complete set
5. Production Line of grain and oil primary processing

(4) Oilseed processing equipment & production line

Cleaning → shelling → crushing → steaming and frying → squeezing → filtering → squeezing oil.

- 100T/D rapeseed oil pressing equipment
- 100T/D tea seed Oil pressing equipment
- 100T/D peanut oil pressing equipment
- 100T/D soybean Oil pressing equipment
Support policy for mechanization industry of grain and oil primary processing
3、Subsidy policy agricultural machinery

Subsidy policy for purchasing agricultural machinery in China
---by Ministry of Agri. & Rural Afair

In 2004, in order to support the development of agricultural mechanization, Chinese government began to implement the policy of subsidizing the purchase of agricultural machinery. At the beginning, and subsidized agricultural machinery focused in tractors and planting machinery, Now it has gradually formed a complete organization and management measures, farmers and cooperatives could apply and get financial support, subsidy ratio is around 30%.

In 2014, primary processing machinery was listed in items of subsidized machinery. From 2021, complete sets of primary processing machinery was listed in items of subsidized machinery.

By the end of 2022, total subsidy fund was about 270 billion RMB, arround 40 billion US dollars.
The National Science and Technology Project for High Grain Yield ---by 3 Ministries

The Projects started in 2004. In view of the grim reality of China's grain production, the Ministry of Science and Technology, the Ministry of Agriculture, the Ministry of Finance and the State Grain Administration joined forces with 12 major grain-producing provinces, based on the three major plains of Northeast China, North China and the middle and lower reaches of the Yangtze River, and started the implementation of the National Science and Technology Project for High Grain Yield around the goals of high yield and high efficiency of rice, wheat and corn.

From 2005-2015 State Grain Reserve Bureau implement a subsidy project for small grain silo suitable for smallholders.
Founded in 1979, named as Chinese Academy of Agricultural Engineering, is a public institute of MOA, Serve China’s Agriculture.

Growing up with Chinese Reform and Opening to Outside World

In 1992, changed name as “Academy of Planning, Design and Research of MOA.

In 2018, changed name again as “Academy Agricultural Planning and Engineering. MARA.
Key Interests

- Agri. Planning & Eng. Consulting
- Remote sensing & Monitoring of Agri. Resource
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- R&D Sub-division of National Agro-food Processing Equipment
- Key Lab. of Agri. Produce Postharvest Processing, MOA
- Key Lab. of Facility and Construction Engineering, MOA
Many Thanks for You all

If you have any questions, please ask us any time at your convenience

Tel: 0086-1059197326 Mobile: 008615701525357
Email: xqizhen@sina.com