

# New technology & prospects for post-harvest rice loss reduction



**Prof. XIE Jian 谢健 教授**  
**China Grain Wuhan Sci. Res. & Design Insti.**  
**国粮武汉科学研究设计院**  
2022.08.24

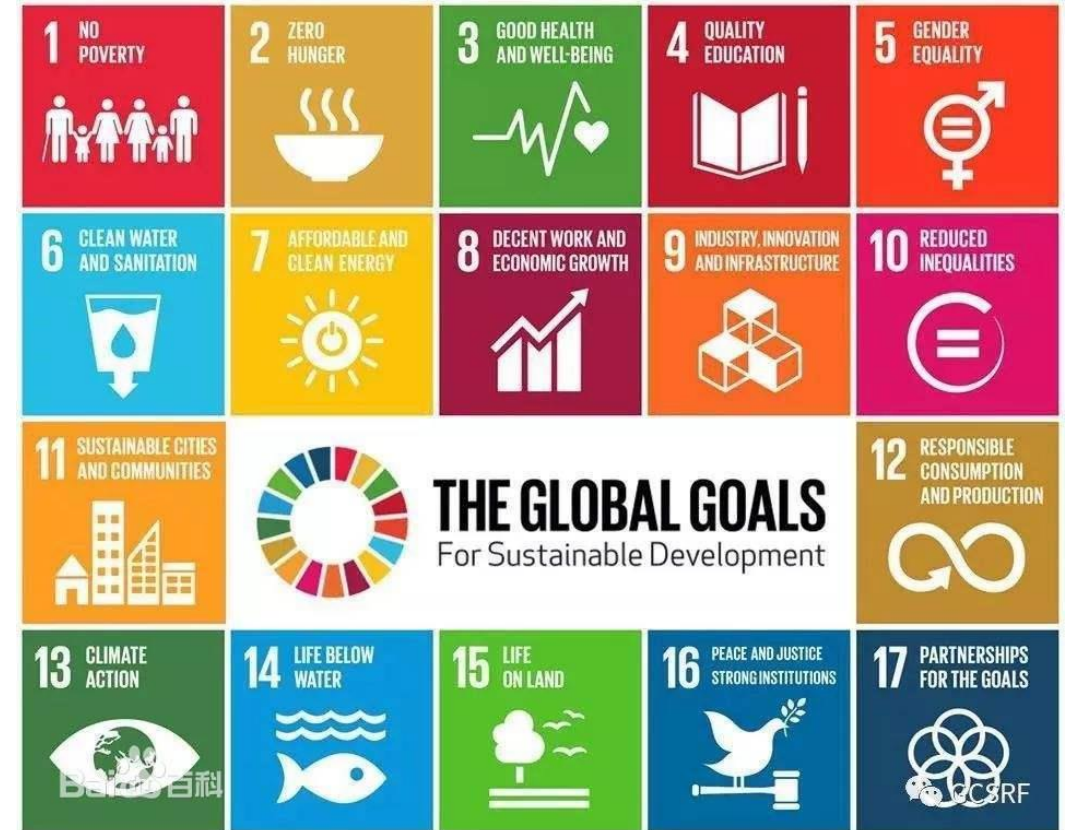
# Rice in China

---

- ◆ > 10,000 years (domestication and cultivation)
- ◆ > 200 million MT ( paddy yield, recent 10 years)
- ◆ > 30% ( of total grain)
- ◆ > 60 % ( consumption of staple food )
- ◆ > 2/3 ( population )
- ◆ rice is the most important staple food resource in China

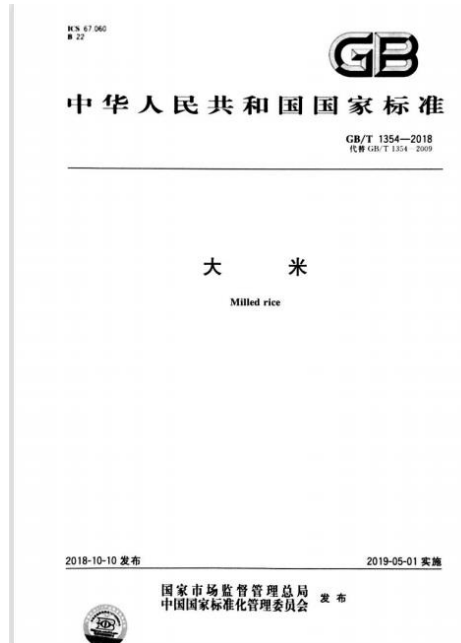
# Rice in World

- ◆  $> 1/2$  (population )
- ◆  $> 1/3$  ( main staple food )
- ◆  $> 1/4$  ( total grain)
- ◆ very important for  
“Zero hunger, Good health & well-being
- ◆ **Global food security**  
(quantity, quality, nutrition, accessibility, affordability, .....



# Achievement in rice tech. of China Grain Wuhan Sci. Res. & Design Insti.

- ◆ 1964 (establish)
- ◆ > 80% (original intellectual property of total in China)
- ◆ > 95% (Standard)
- ◆ > 500 sets (Engineering & design & EPC)
- ◆ > \$15 million (business income in 2021)



# key treatment sections for post-harvest rice

wet paddy from field



**drying** (wet paddy → dried paddy)



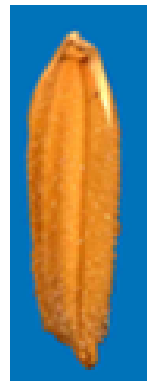
**store** ( storage )



**milling** (cleaning → husking → whitening → redressing → packing)



milled rice



- 
- 1. Loss types of post-harvest rice**
  - 2. New Technology for rice loss reduction**
  - 3. Prospects**

# 1. Loss types of post-harvest rice

wet paddy



**drying** (wet paddy ⇒ dried paddy)



remove excess moisture  
separate some impurities (large, small, light, etc.)

**store** (temporary storage)



insect, mildew, rat and bird prevention  
prevent quality degradation

**milling** (dry paddy ⇒ brown rice ⇒ white rice ⇒ milled rice)

remove husk, bran, bran powder from rice kernel,  
separate all by products (husk, bran, yellow kernel, chalky kernel, etc.)  
separate all impurities (large, small, light, heavy, etc.)

milled rice

dry paddy  
brown rice  
white rice



# potential losses & causes in sections

type of loss	causes	drying	store	milling
quantity loss	exceed grain content in impurities / by-products/reject or due to leakage	√ √ √	√	√ √ √
quality loss (nutrition loss )	heat damage due to over temp.	√ √ √	√ √ √	√ √
quantity loss & quality loss (nutrition loss )	damaged by rats, birds, insects, fungi	√	√ √ √	√
	ultra low moisture due to over-drying	√ √ √	√	√
	high broken kernel rate due to over-pressure / impact /internal stress variation/ temp. difference	√ √ √	√	√ √ √
	high crack kernel rate due to over-pressure / impact /internal stress variation/ temp. difference	√ √ √	√	√ √ √
	over milling due to exceed milling degree			√ √ √



---

1. Loss types of post-harvest rice

**2. New technology for rice loss reduction**

## **2. New technology for rice loss reduction**

---

**2.1 New technology for drying**

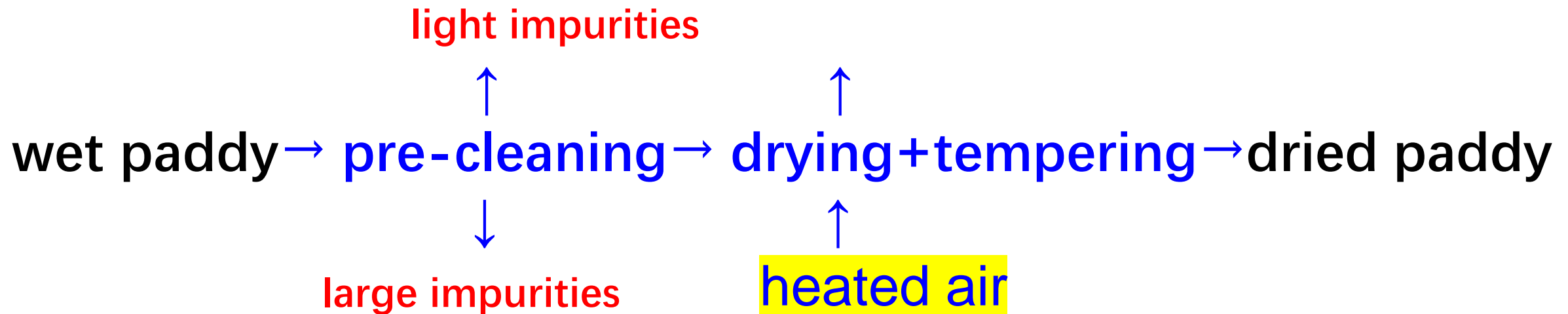
**2.2 New technology for store**

**2.3 New technology for milling**

# 2.1 New technology for drying

remove the excess moisture of wet paddy **smoothly**

## Flow sheet



## 2.1.1 New technology for pre-cleaning

wet paddy → pre-cleaning → (drying+tempering) → dried paddy

**key:**

- carefully design the flow, especially the drying process
- low temperature drying
- low speed drying
- sufficient tempering
- choose high efficient equipment
- automatic control / intelligent control

## 2.1.2 New technology for drying+tempering

key 1: **carefully design** the drying flow

### Flow sheet



## 2.1.2 New technology for drying+tempering

---

**key 1: carefully design the drying flow**  
**combined drying flow**

high moisture paddy ( $> 20\%$ )



**1st drying** (to  $\sim 20\%$ )



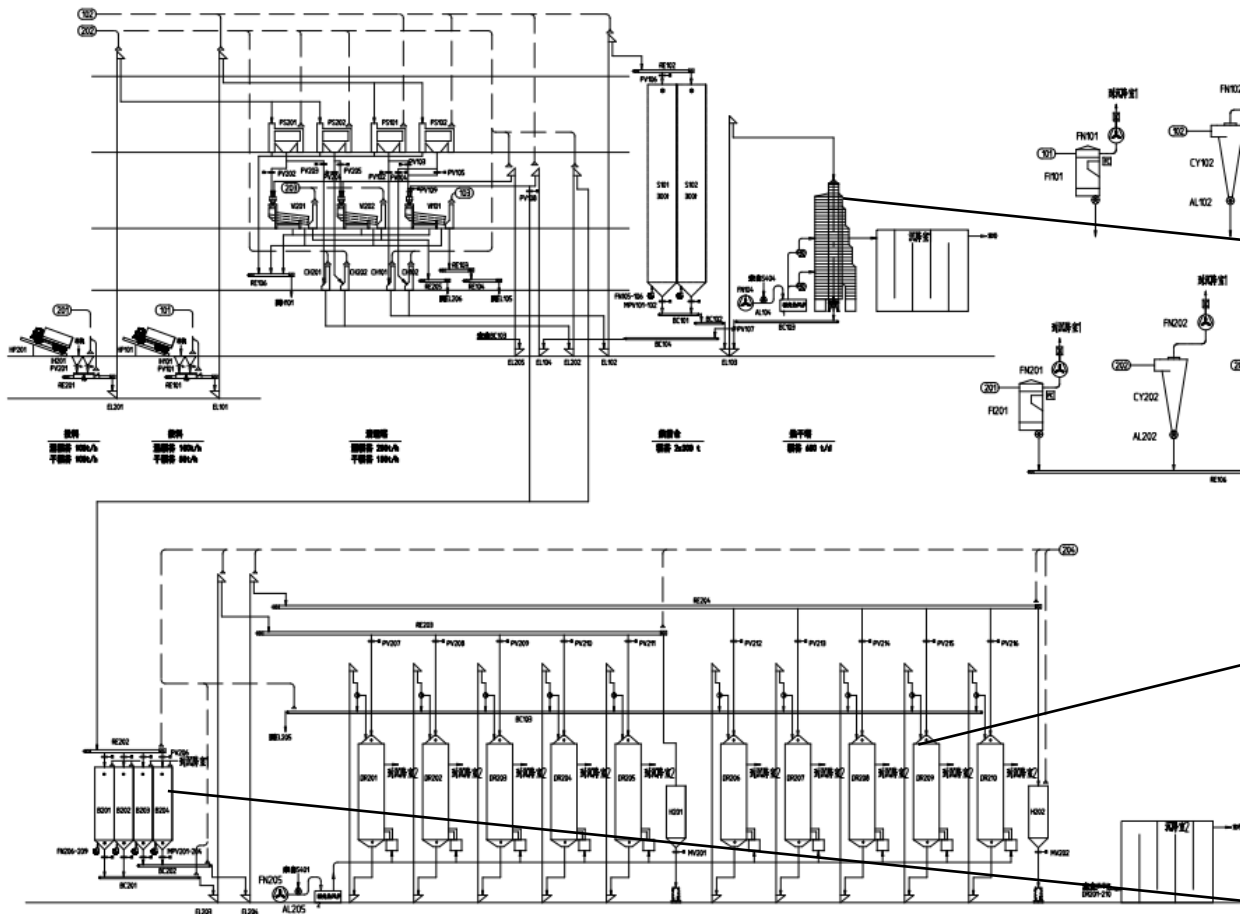
**tempering bin/ chamber** (sufficient)



**2nd drying** (low speed drying to  $\sim 16\%$ )

# 2.1.2 New technology for drying+tempering

key 1: **carefully design** the drying flow



1st drying  
(rapid drying)

2nd drying  
(slow drying)

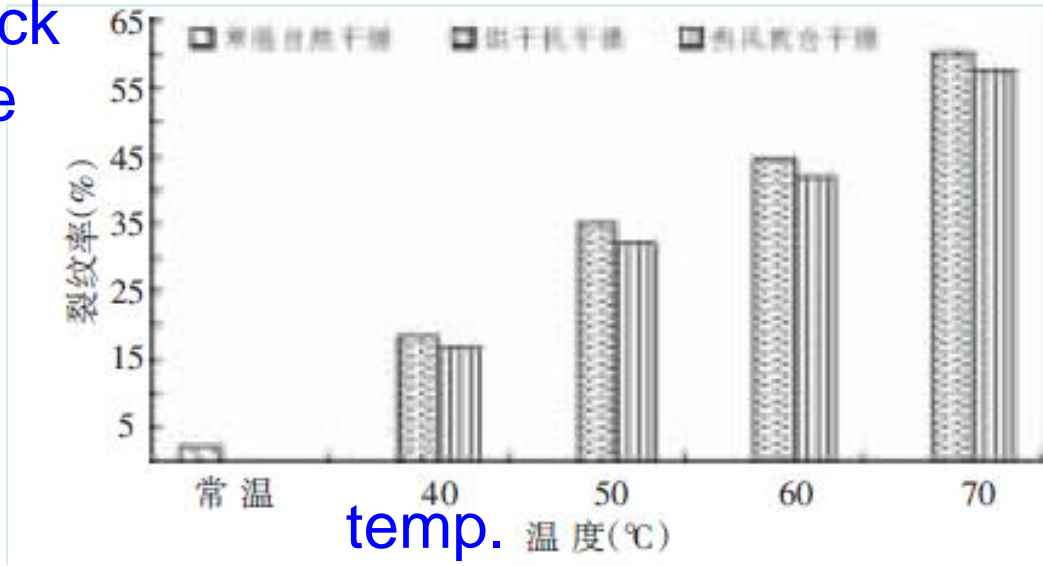
tempering silo

# 2.1.2 New technology for drying+tempering

key 2: lower term. drying

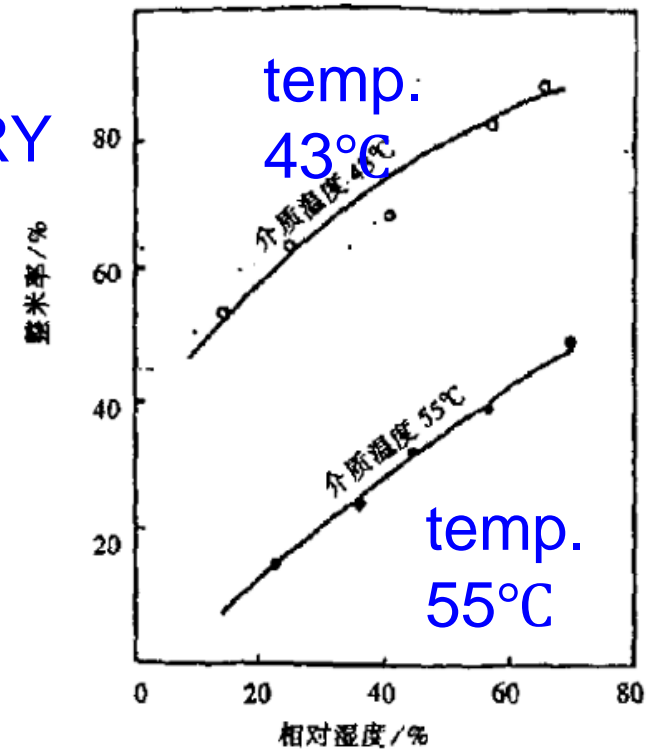
lower crack rate, higher Head Rice Yield(HRY)

crack rate



crack rate vs. drying temperature

HRY

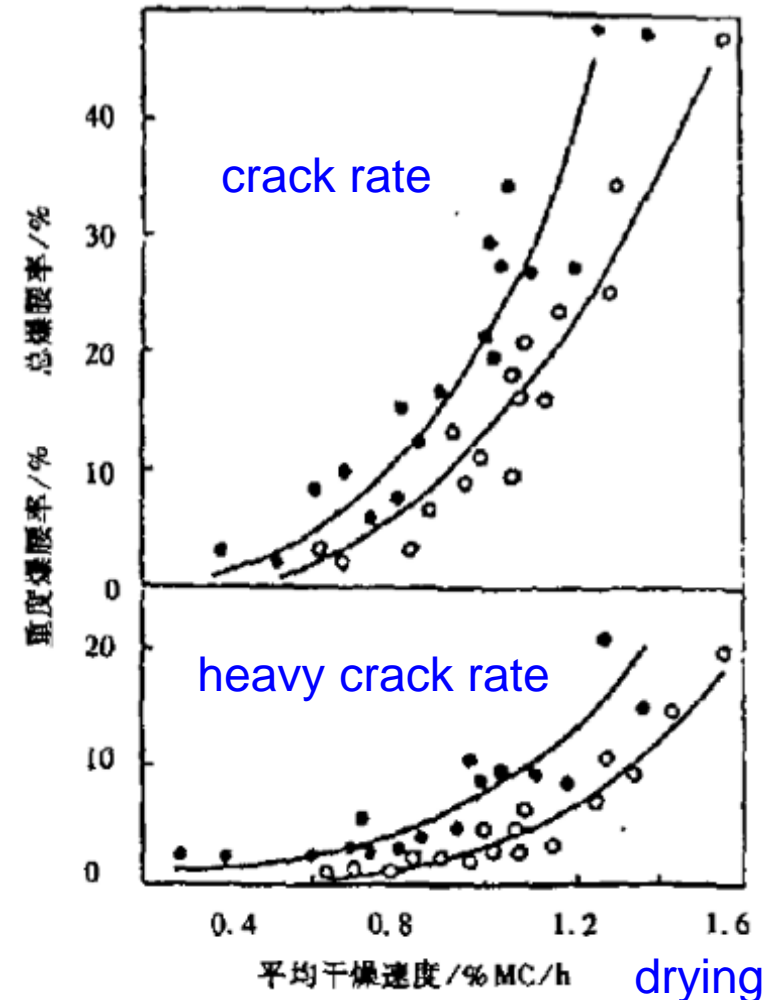


HRY vs. drying temperature



# 2.1.2 New technology for drying+tempering

key 3: lower speed drying  
 lower total crack rate,  
 lower heavy crack rate raise

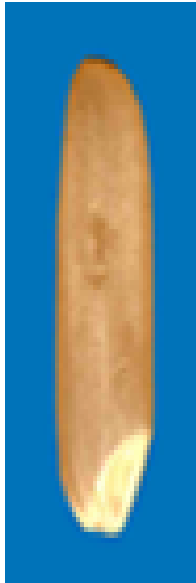
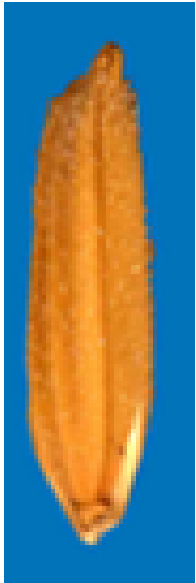


Crack rate (Heavy crack rate)  
 vs. Drying speed

drying speed

# 2.1.2 New technology for drying+tempering

key 4: sufficient tempering  
 lower crack rate raise,  
 lower broke rate raise



	drying temp.	tampering time: drying time			
	(°C)	non stop	1:1	2:1	3:1
crack rate raise (pentagon point)	45	1.9	0.9	0.8	0.7
	50	6.6	2.9	2.0	1.9

## 2.1.2 New technology for drying+tempering

**key 5: choose high efficient equipment**

**batch type recirculating dryer (indoor type)**

for lower speed drying  
( wet paddy moisture < 20%)



6~50 t/ batch (indoor type)

## 2.1.2 New technology for drying+tempering

**key 5: choose high efficient equipment**

**batch type recirculating dryer (outdoor type)**

for lower speed drying  
( wet paddy moisture < 20%)



50~130 t/ batch  
(outdoor type)

## 2.1.2 New technology for drying+tempering

**key 5: choose high efficient equipment  
continuous dryer**

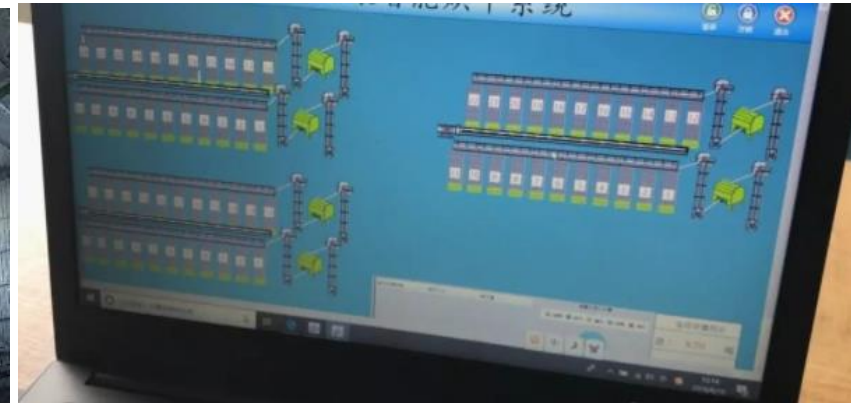
for drying higher moisture paddy (> 20%)



200~1,000 t/ 24h

# 2.1.2 New technology for drying+tempering

key 6: automatic control / intelligent control



drying center / postharvestservice center

## 2. New technology for rice loss reduction

---

2.1 New technology for drying

**2.2 New technology for store**

2.3 New technology for milling

## 2.2 New technology for store

---

keep paddy in good quality

Flow sheet

pre-cleaned dry paddy → warehouse / bin → ( to milling )  
↑  
(cool air, N<sub>2</sub> / CO<sub>2</sub>)



## 2.2.1 lower temp. storage

---

keep paddy in good quality

◆ key

- lower temp. storage

heat insulation + mechanical ventilation + temperature control + cooling

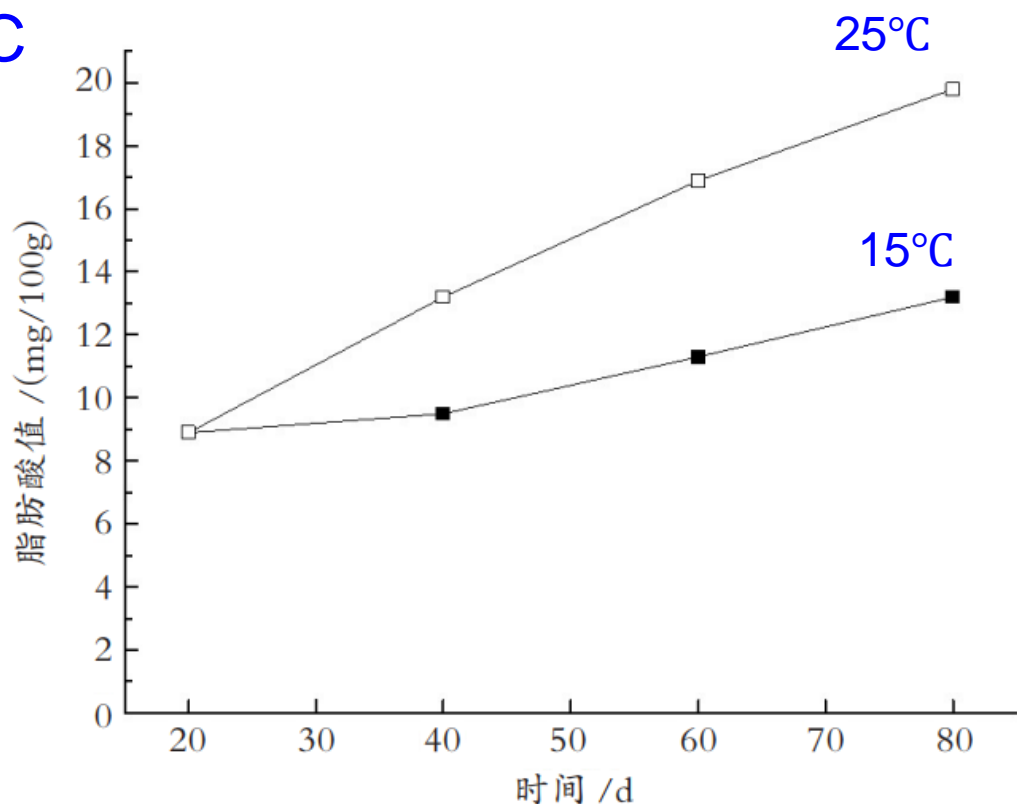
- lower O<sub>2</sub> storage

air-tight + controlled atmosphere (filling CO<sub>2</sub> / N<sub>2</sub>)

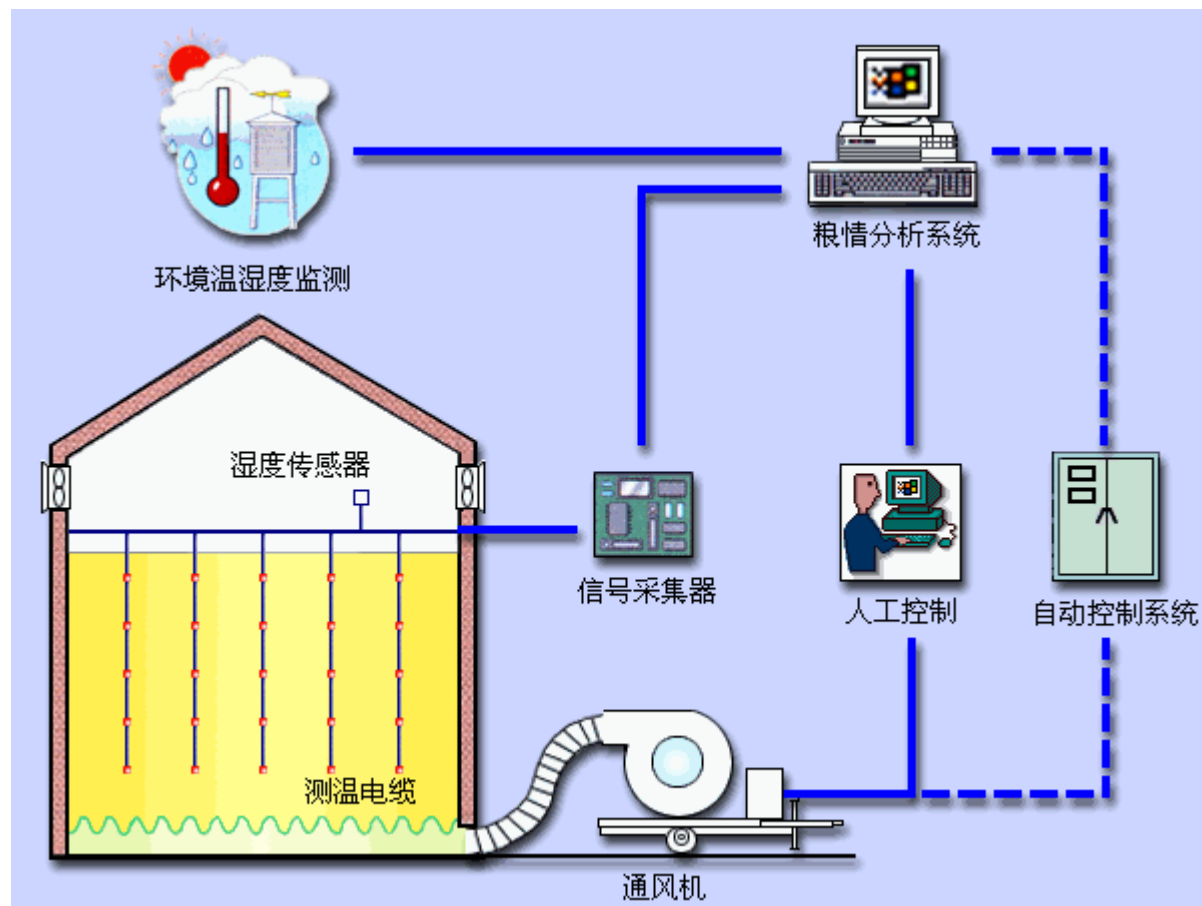
# 2.2.1 lower temp. storage

lower temp. storage for **control insects, fungi & FAV**

FAC



Fat Acid Value vs temperature



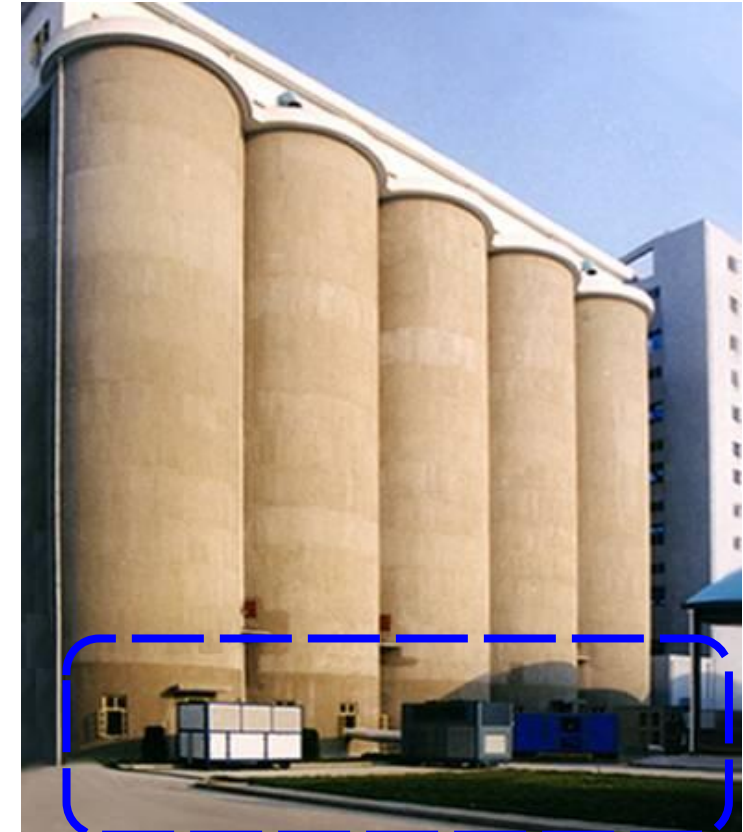
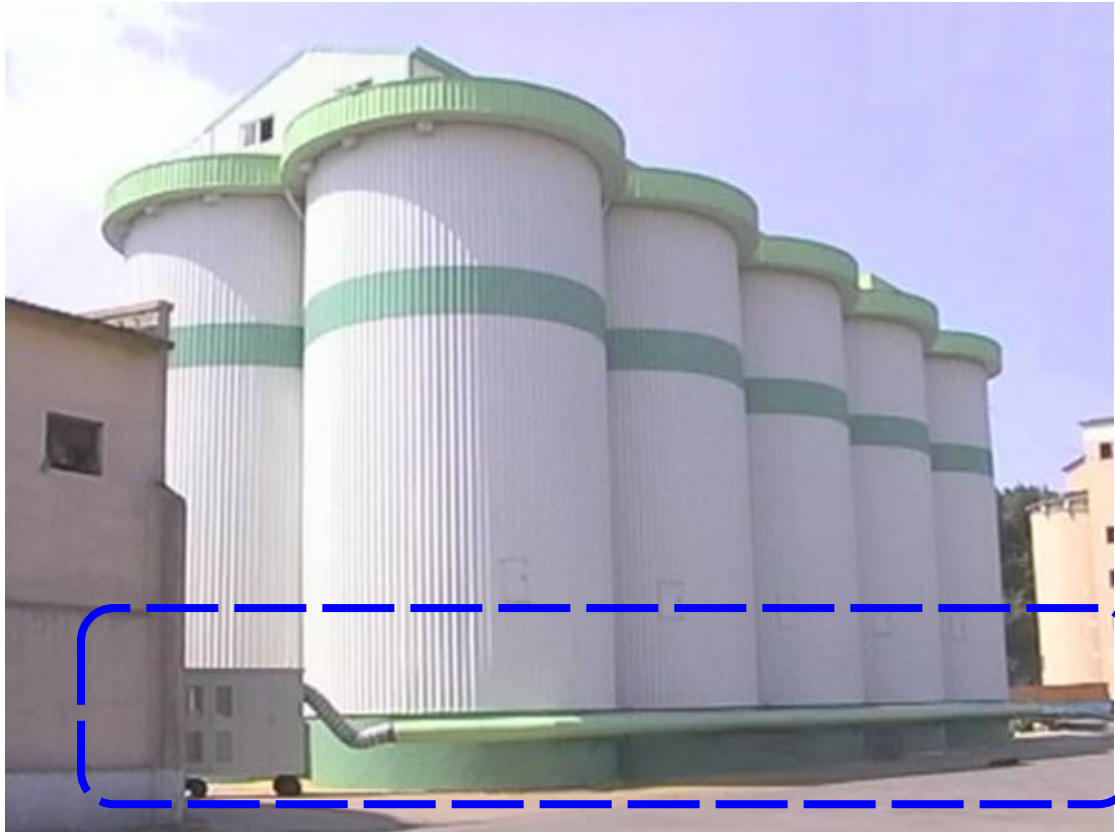
# 2.2.1 lower temp. storage

silos (air-tight, heat isolation)



# 2.2.1 lower temp. storage

grain cooling ( control insects, fungi & FAV)

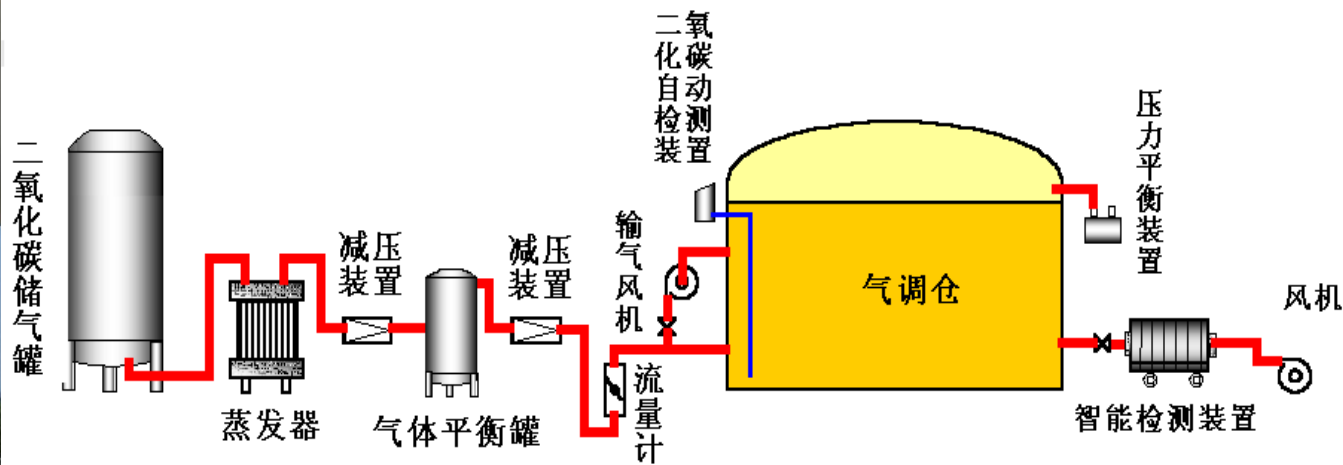


# 2.2.2 lower O<sub>2</sub> storage

controlled atmosphere ( control insects, fungi & FAV)



CO<sub>2</sub> tank



N<sub>2</sub> separator

## 2. New technology for rice loss reduction

---

2.1 New technology for drying

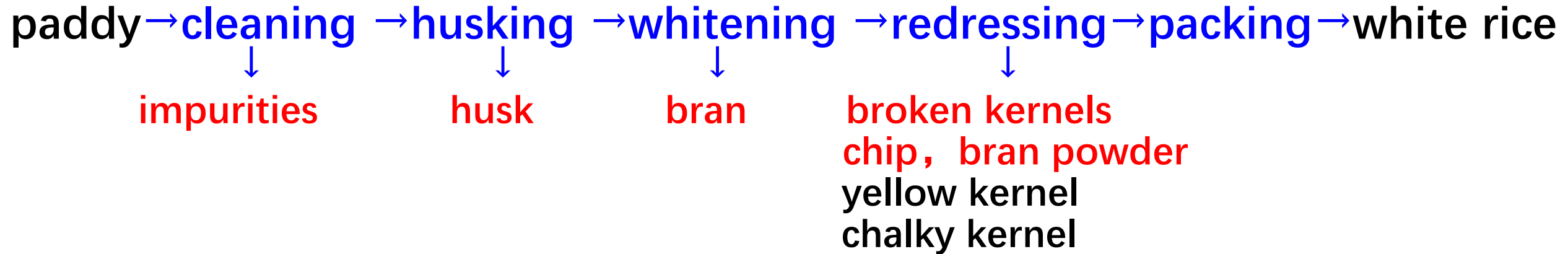
2.2 New technology for store

**2.3 New technology for milling**

# 2.3 New technology for milling

remove the husk & bran **smoothly**

## flow sheet for white rice



## flow sheet for parboiled rice



## 2.3.1 New ventilation system

paddy → cleaning → husking → whitening → redressing → packing

### key:

- carefully design the ventilation system of husk, bran, bran powder, etc.
- choose high efficient equipment  
lower broken, lower power consumption,  
lower temp. raise, automatic, precise, etc.
- carefully design the flow



# 2.3.1 New ventilation system

key 1: **carefully design** the ventilation system



**separator**

paddy from air  
less paddy be carry  
away by aspiration  
system

stoner

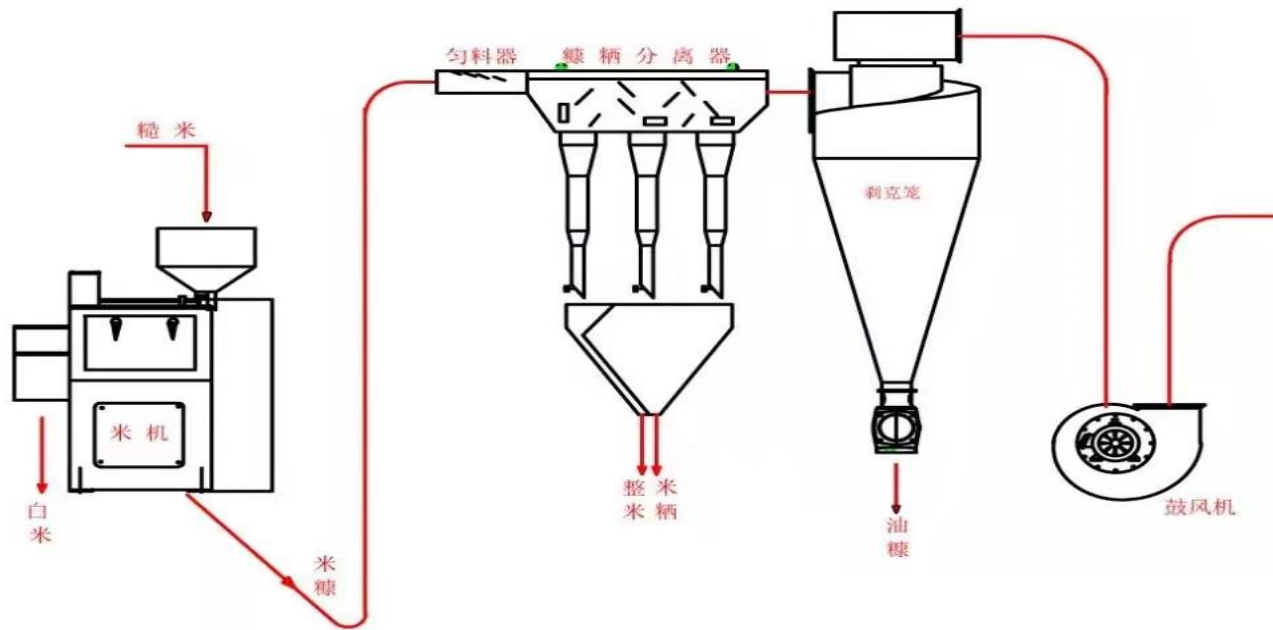
paddy back to machine  
less paddy be carry away



reduce paddy kernel  
in light impurities

# 2.3.1 New ventilation system

key 1: **carefully design** the ventilation system for **bran separating**



whitening machine

mixture →  
bran  
brokens  
chip



→ bran

↓ ↓ ↓  
brokens chip

# 2.3.1 New ventilation system

key 2: choose **high efficient equipment**

key equipment 1: aspiration separator

↑ light **impurity** with wind

vertical aspiration separator

vibrating feeder



H suspension velocity



↓ paddy

## 2.3.2 High efficient equipment

key 2: choose **high efficient equipment**

key equipment 2: **husker+husk separator**



V.S.



Intelligent control frequency conversion

- Auto adjust the speed of fast roller and slow roller respectively, according to the change of rollers' diameter, stabilized line-speed difference, lineal-speed sum
- broken rate drop : **>1** percentage point and more

# 2.3.2 High efficient equipment

key 2: choose **high efficient equipment**

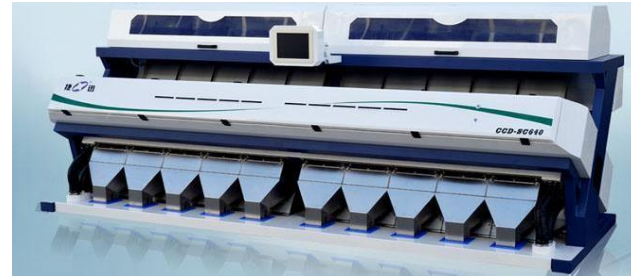
key equipment 3: **paddy separator+brown rice grader**



+



V.S.



before

after  
immature

brown rice

red brown  
rice

paddy

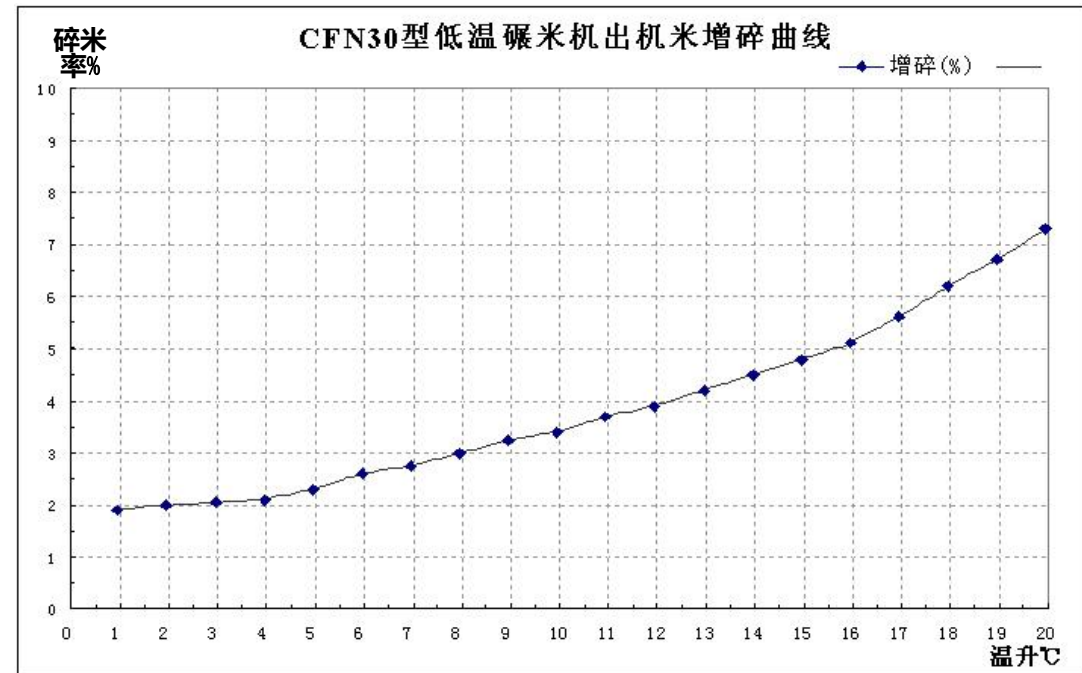
diseased  
kernel



# 2.3.2 High efficient equipment

key 2: choose **high efficient equipment**

key equipment 4: **lower temp. raise whitening machine**



broken rate V.S. temp. raise

## 2.3.2 High efficient equipment

key 2: choose **high efficient equipment**

key equipment 5: **auto lower temp. raise whitening machine**

compared with traditional whitening machine

temperature raise: ↓**15 °C~20 °C**

broken rate: ↓**6 percentage points**

power consumption: ↓**10 kWh /Mt milled rice**

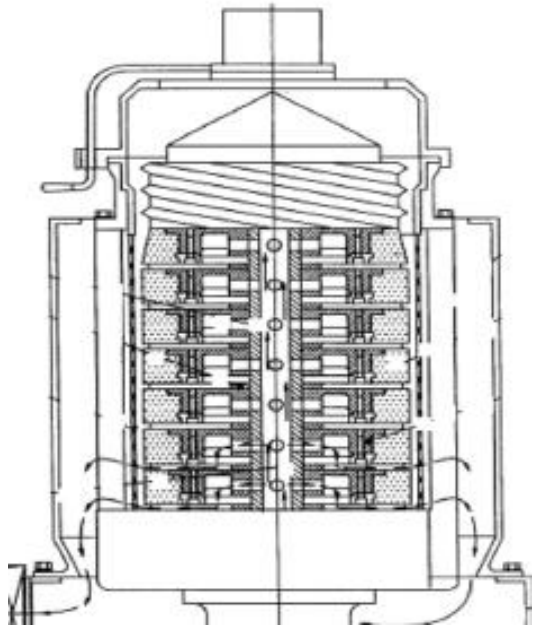


- frequency conversion
- HMI touch screen control
- automation

## 2.3.2 High efficient equipment

key 2: choose **high efficient equipment**

key equipment 5: auto **lower temp. raise whitening machine**



former

V.S.



new



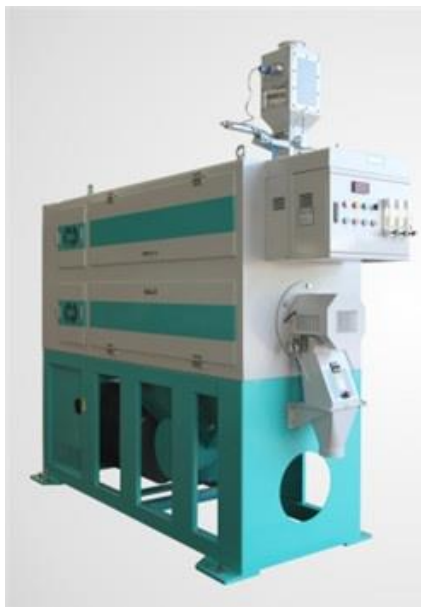


## 2.3.2 High efficient equipment

key 2: choose **high efficient equipment**

key equipment 6: rice soft brusher

reduce broken rice rate raise



polisher's roll (SS)

VS



桐城市新锐制刷



brusher

## 2.3.2 High efficient equipment

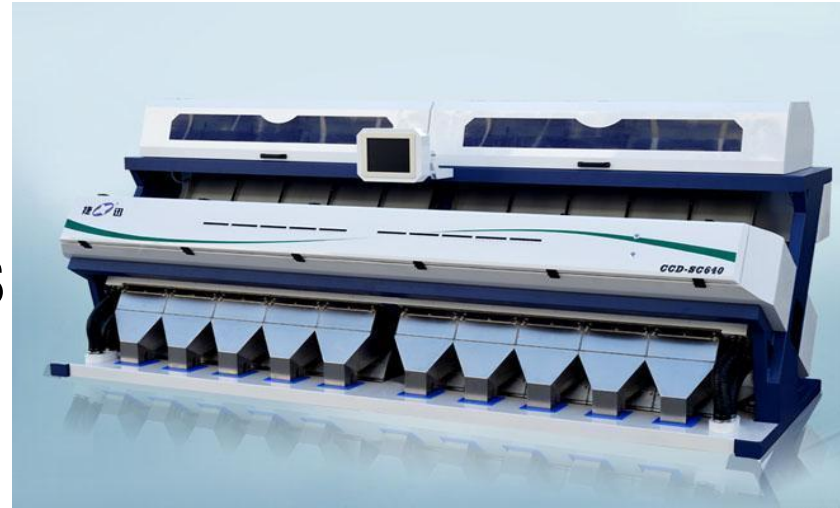
key 2: choose **high efficient equipment**

key equipment 7: color sorter



old

VS



new

technology:

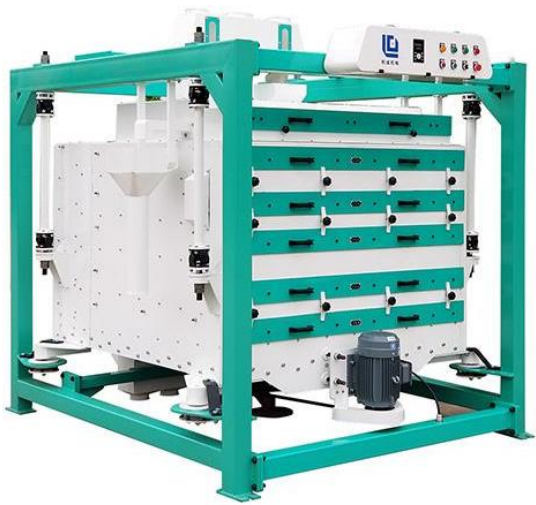
- IoT
- iCloud
- big data
- AI

precise separate yellow kernel, chalky kernel, etc  
extremely low carryover ratio (150~100:1)

## 2.3.2 High efficient equipment

key 2: choose **high efficient equipment**

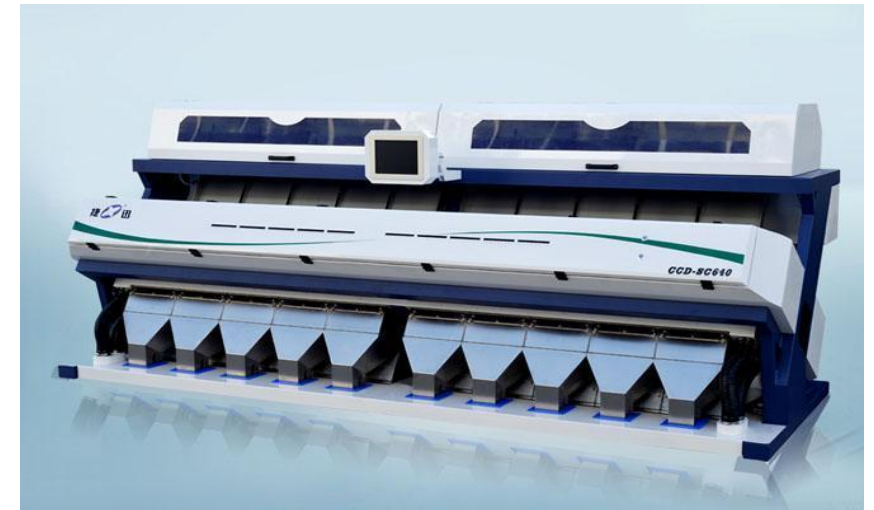
key equipment 8: rice grader



+



VS



sifter

length grader

color sorting

precise separate & control broken rice rate

# 2.3.3 New technology for packing

key 1: choose **good packing material**

**keep the product in right condition, for longer shelf life**

- **air-tight (Oxygen resistance)**: plastic bag, PET bottle & tinplate can or Al can
- **stab resistance**: vacuum packaging bag
- **light proof**: tinplate can / Al can /



## 2.3.3 New technology for packing

key 2: choose **high efficient equipment**

auto weighing machine + auto sewing machine (for PP bag)



# 2.3.3 New technology for packing

key 2: choose **high efficient equipment**

**weighing +sealing machine (plastic bag, vacuum bag)**



**weighing +vacuum packaging machine**

# 3. Prospects

---

- 3.1 Digitalization and informatization**
- 3.2 Self coordination & intelligent control**
- 3.3 Intellectualization of rice enterprise**

# 3.1 Digitalization and informatization



On December 26, 2019, the **real time production data of Intelligent rice whitening machine** was communication with the cloud database



# 3.2 Self coordination & intelligent control

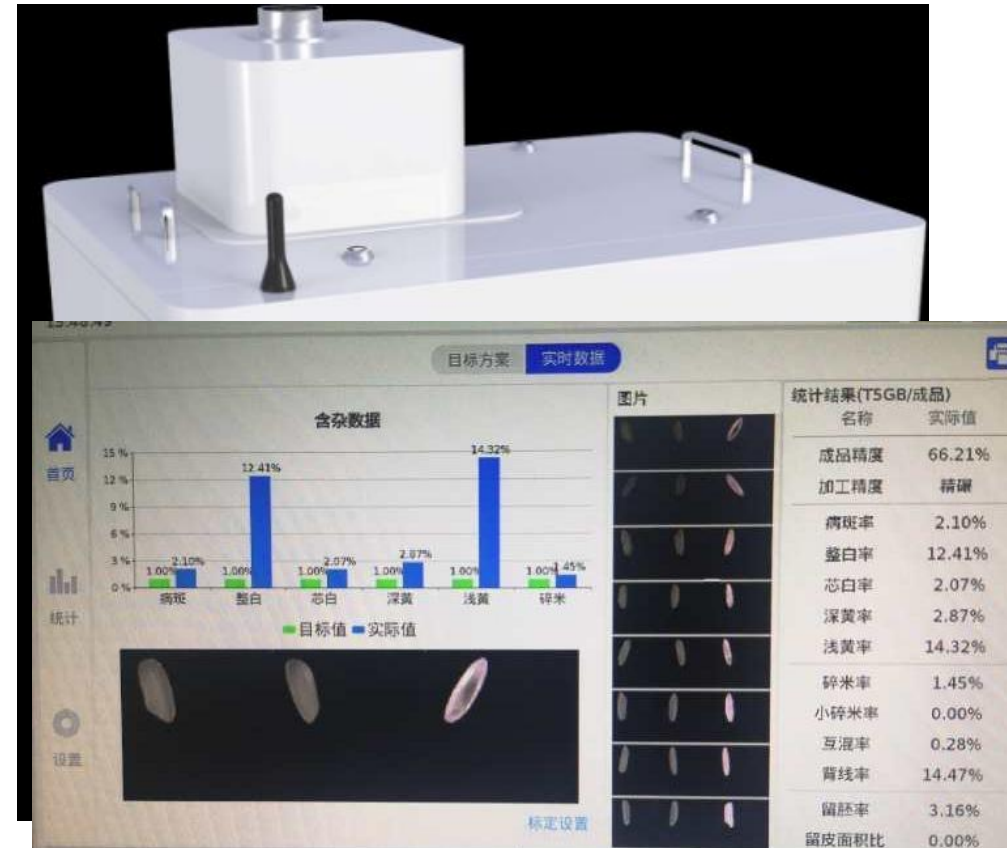


manual detection



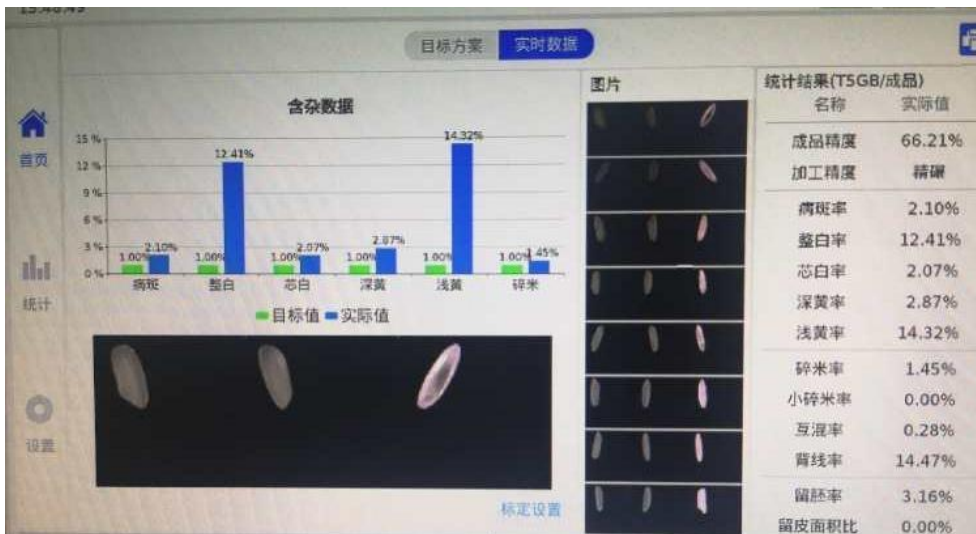
offline detector

VS



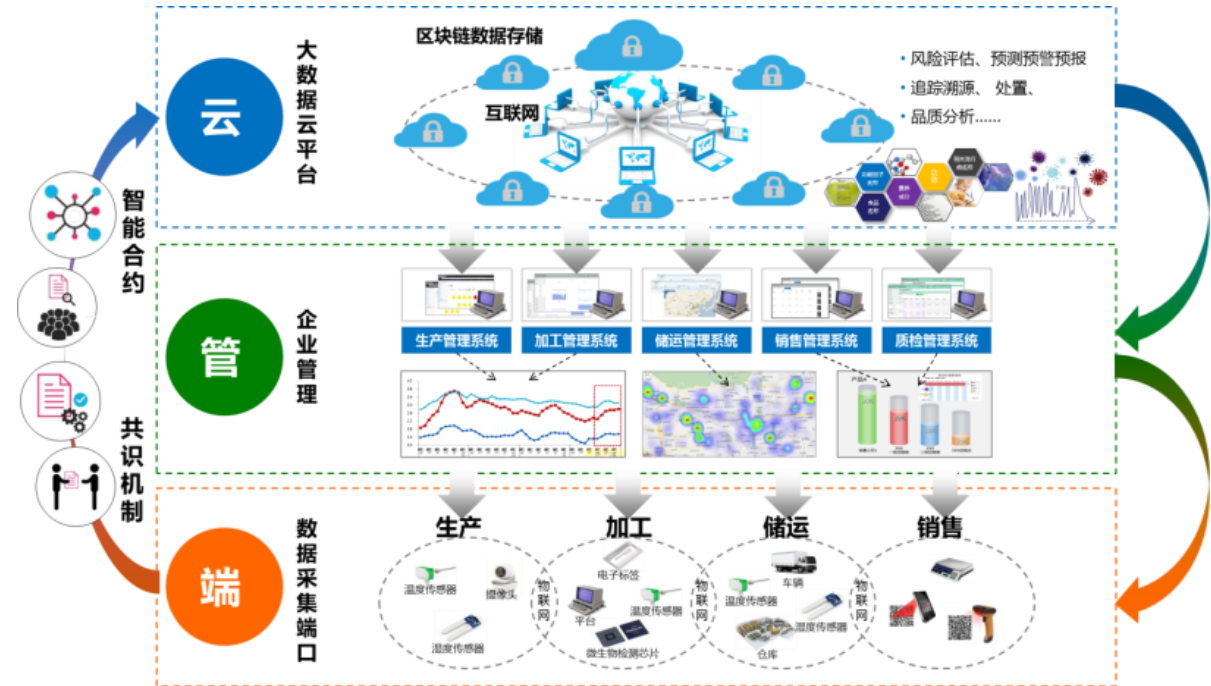
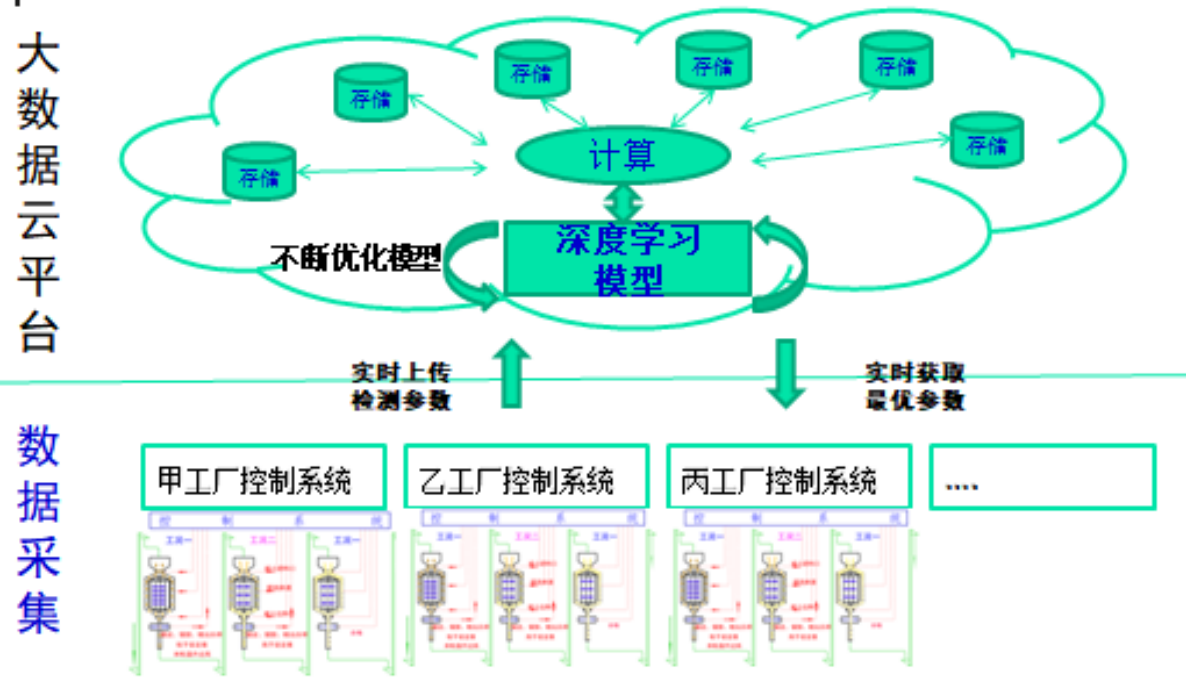
Rice kernel appearance quality 360° online detector

# 3.2 Self coordination & intelligent control



Intelligent rice whitening machine+Rice kernel appearance quality  
 360° online detector = Intelligent rice whitening line= lower broken rate

# 3.3 Intellectualization of rice enterprise



real time production data / raw material data / product inventory data + cloud database + machine learning , AI = **Intellectualization of rice enterprise**

---

**Thank you**  
**谢谢聆听!**

**[pxiejian@126.com](mailto:pxiejian@126.com)**