

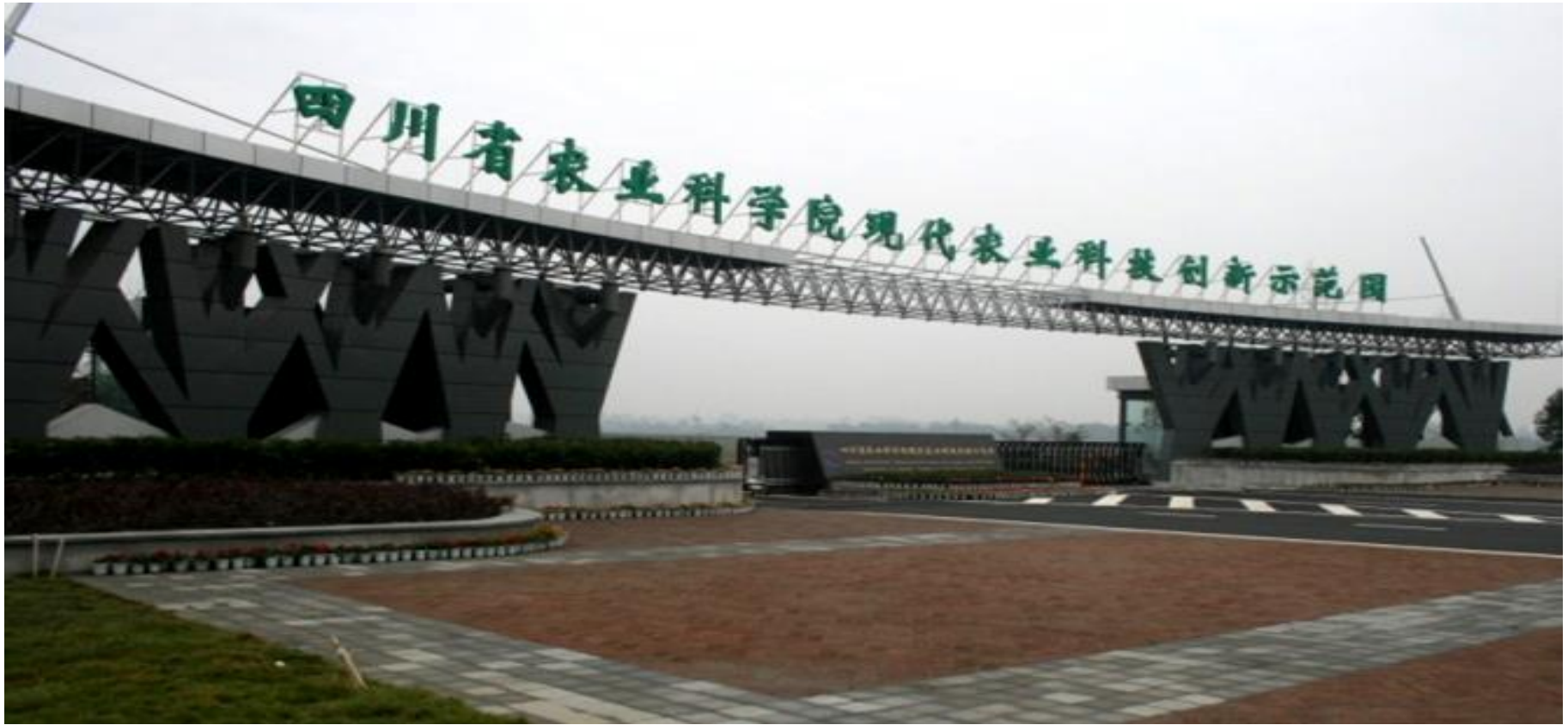
# Developments and advances in sweetpotato processing in China

Institute of Agro-products Processing Science and Technology of  
Sichuan Academy of agricultural Sciences (SAAS)

**Xie Jiang**

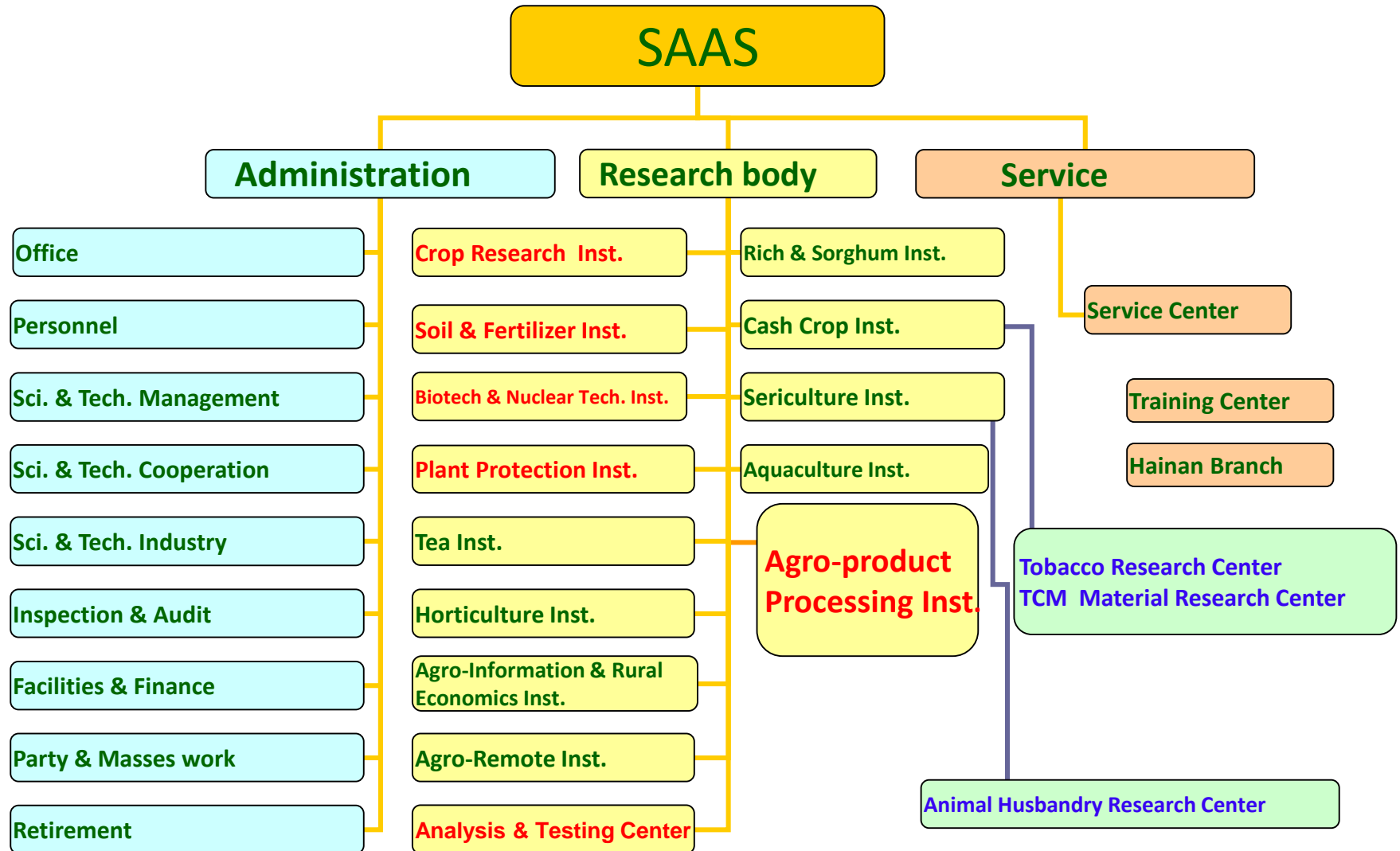
[xie66880466@126.com](mailto:xie66880466@126.com)

- 1. Background of sweetpotato(SP) & Agriculture in Sichuan Province, China**
- 2. Marketing of SP products**
- 3. Consumer acceptance of SP products**
- 4. New post-harvest technologies  
guide/support SP processing industry**
- 5. Machines for processing**



- Sichuan Academy of Agricultural Sciences(SAAS) was founded in 1935, run by government. It plays a very important role in Sichuan's Agriculture science.

# Sichuan Academy of Agricultural Sciences (SAAS)







- Sichuan Province located in the southwest of China, it is the most important Sweetpotato and agriculture production area in China with its favorite natural condition of hilly land, valley and high mountain area.

In Sichuan Province, **sweet-potato** and potato **rank first** both in China and in the world by the planting area and total yield.

Name	Area (million ha)	Yield(million ton)
sweet potato	0.87	15
Potato	0.6	12

1. **Background of sweetpotato(SP) & Agriculture in Sichuan Province, China**
2. **Marketing of SP products**
3. **Consumer acceptance of SP products**
4. **New post-harvest technologies  
guide/support SP processing industry**
5. **Machines for processing**

# Marketing of SP products

## 1.Traditional noodles

- 1) normal noodles for family dish
- 2) Hot pot use
- 3) Stable need

## 2.SP snack foods

- 1) SP cracker(successful from manual to machine line)

## 3. SP flour

- 1) main food(table food along with government promoting)

## 4. Healthy SP foods

- 1) new products of fermented products for heart and blood fat etc.  
cake, flour, noodle with wheat flour etc.

# Consumer acceptance of SP products

	Before 1980	After 2000	Now
Fresh SP	More table foods	less	More and more table foods
SP starch & Its use	As normal noodle by manful	More noodle of Manual made & Machine made	1. Instant noodle 2. With healthy ingredients
SP snack foods	Fresh chip	Restructured chip Cracker	
SP flour & Its derived foods		SP flour Instant flour	Baked foods Mixed noodle with wheat SP beverage SP wine
SP puree & Its derived foods			Frozen cake Mixed noodle with wheat

# SP Starch-noodle

- Traditional consumption of SP products promote the SP processing development
- Successful industry and R&T
- Successful value chain of SP industry

## **Sweet-potato Production and utilization in Sichuan Province**

- 1) In the past years before 1980, sweetpotato(SP) was used as a table food, it had played a very important role in food safety and livelihood especially in the countryside.
- 2) From 1980', under the support of SAAS, successful agro-industry from production to processing with the future such as starch and noodle processing. This processing has been carried out in more than ten counties such as San Tai, Anyue, Pengxi, Yibin and other counties.
- 3) Farmer—small/medium processor----big processor form the industrial chain.

# starch processing system

**Coarse starch** (medium scale or small scale by farmers)



**Refined starch** (medium and large scale)



**Series products**

{	<b>Whole Instant noodle</b>	<b>40%</b>
	<b>Starch noodle</b>	<b>35%</b>
	Food industry and Cooking	15%
	Family cooking	10%



Starch for cooking and food processing



biscuit made from wheat flour and starch



Starch dumpling

## ***Improved starch procedure:***

Fresh root---wash---smashing--filtration---“**sour liquid**” --  
-deposit---refining---deposit---exchange water---  
dehydration---drying



# Starch processing





# Noodle processing-1

## 1) by manual

(hot water method)



**by machine,**

(hot water method)

**machine used:**

- ① mixing machine
- ② vacuum machine
- ③ noodle machine
- ④ freeing machine

**noodle Usage:**

good tolerance, for hot pot, soup



# Family enterprise and modern factory making noodles



Family enterprise  
(traditional)



modern factory



## Noodle processing-2/3

**extruding machine(with external heating),  
machine used:**

- ① mixing machine
- ② noodle machine
- ③ freezing machine

**noodle Usage:**

good tolerance, for instant noodle, soup



## Noodle processing-4

Sheeting method noodle procedure :  
starch → mixing → sheeting → steaming

→ cooling → aging → cutting

→ shaping → drying → packing



## **machine line: (sheeting method)**

① mixing machine      ② noodle machine      ③ freeing machine etc.

### **noodle Usage:**

good tolerance, for instant noodle, soup



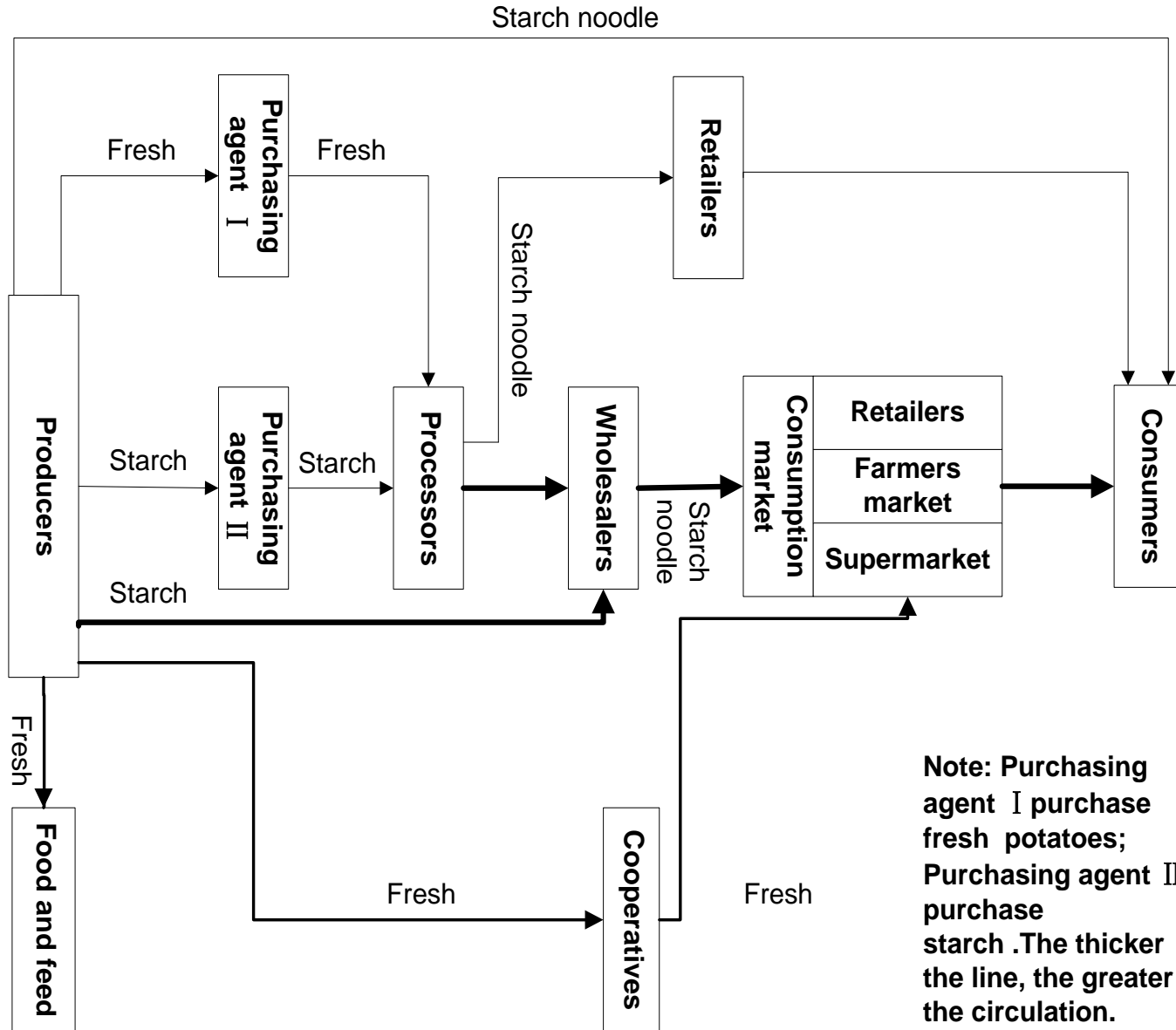




**Whole nutrition instant noodle made by extruding machine**



# Sweet Potato Value Chain in Sichuan China(starch & noodle)



## Key points:

Farmers  
Processor Company  
Tech. source Institute  
Machine source

**Note:** Purchasing agent I purchase fresh potatoes; Purchasing agent II purchase starch. The thicker the line, the greater the circulation.

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# **New post-harvest technologies guide/support SP processing industry**



New main technologies by SAAS and Sichuan Industry :

- 1 Refined starch in different scale by machine
- 2 SP noodle machine line(4 types)
  - 1) Industrial production line with manual hot water method
  - 2) Sheeting machine line
- 3 Instant noodle line
- 4 SP flour line(3 types of drying), with SP puree energy-saving drying technology and machine line
- 5 SP storage facilities (auto control temp. RH O<sub>2</sub> CO<sub>2</sub> etc.)



Sweetpotato ball







Sweetpotato craker



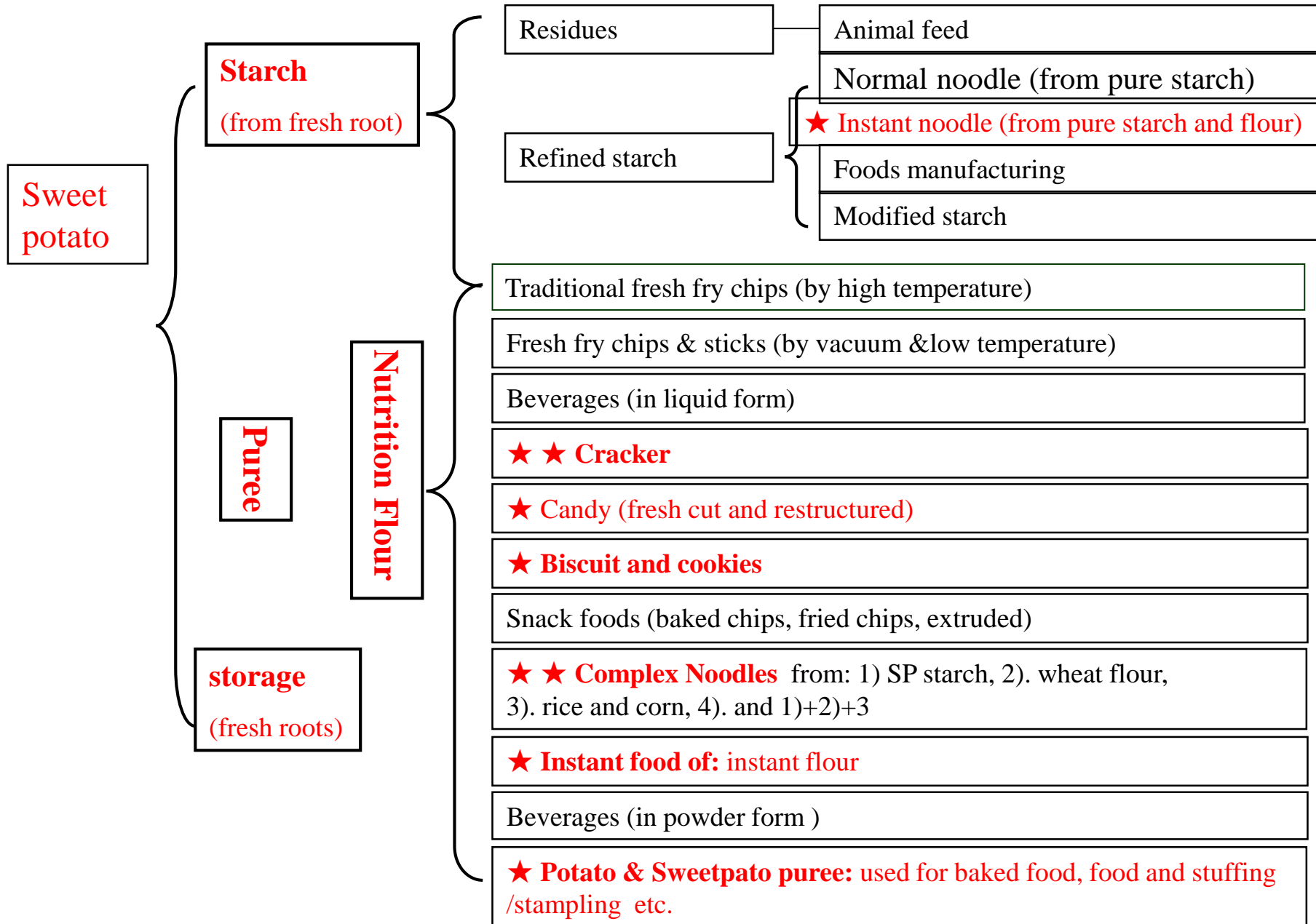
Sweetpotato candy

# Sweetpotato candy





# Main products of sweetpotato



# Sweetpotato & potato chips





# Sweetpotato puree



**Sweet potato flour**

# Sweet potato flour

- Developed from starch
- Energy saving technology (30%)
- Well maintaining the nutritional elements and flavour of fresh roots
- Suitable for OFSP and other sweetpotato
- Can be used in food widely (derived foods together with puree)

# Sweet potato flour

**There are four improved technology system for flour:**

1. Chip drying technology (by hot air house/box dryer)

1)fresh non-gelatinized flour, 2)semi-gelatinized flour, 3)full-gelatinized flour

2. Hot air current drying technology (granule flour products)

3. Drum drying technology (flake products)

4. Spray drying technology (beverage etc.)





# Products from sweet potato and puree

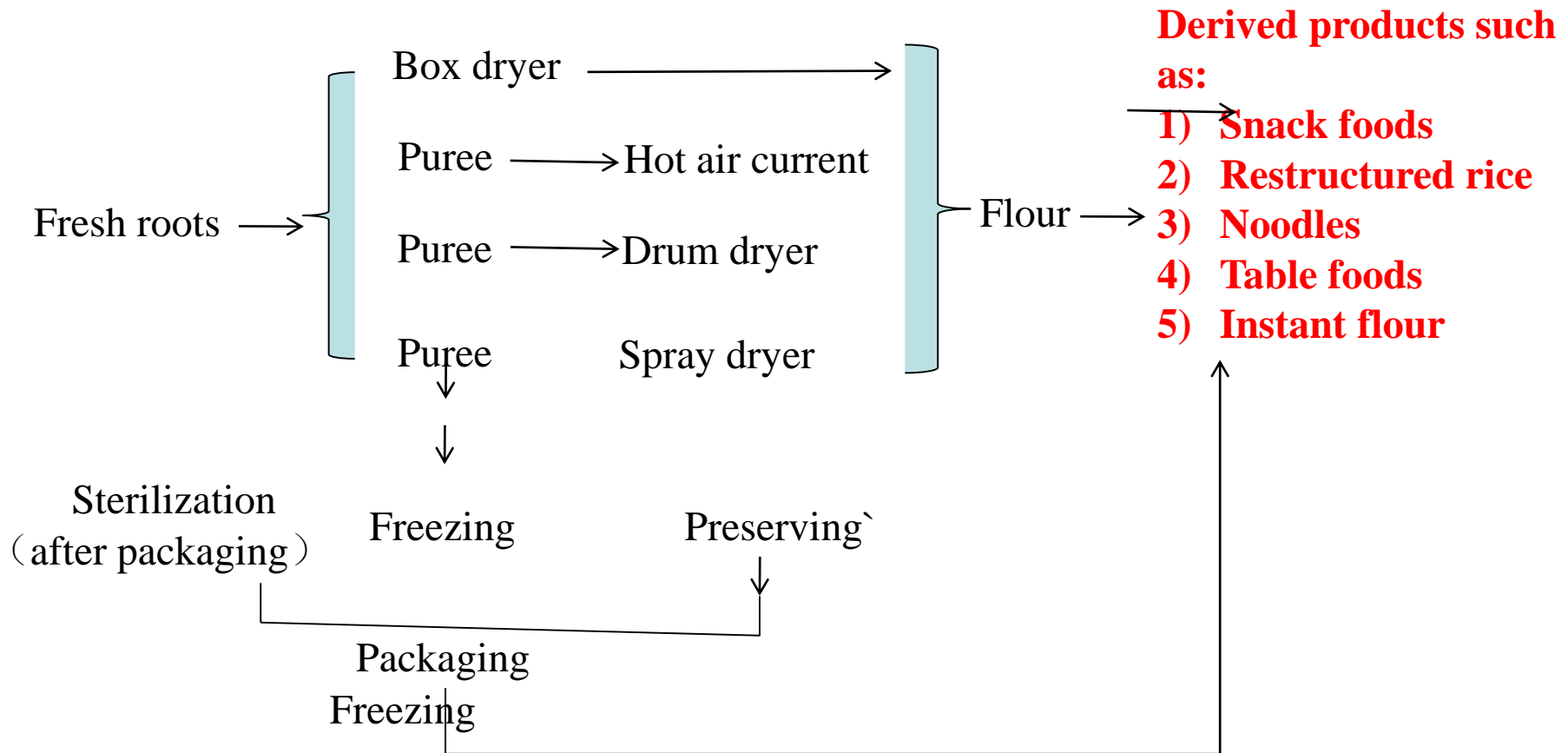


# OFSP

- Products system
  - a. OFSP has Good flavour and preserve rich nutrition VA etc.
  - b. Market need
  - c. Best profit
- Technology & machine system in SAAS, China
  - a. The processing & storage industry/story in Sichuan,
  - b. SAAS R&D and exchange in Sichuan, China and overseas
- Actors
  - 1) Factory(company, farmers, cooperatives and their combination system)  
products: craker , noodle etc(主食化table food)
  - 2) Government,(provide better policy )

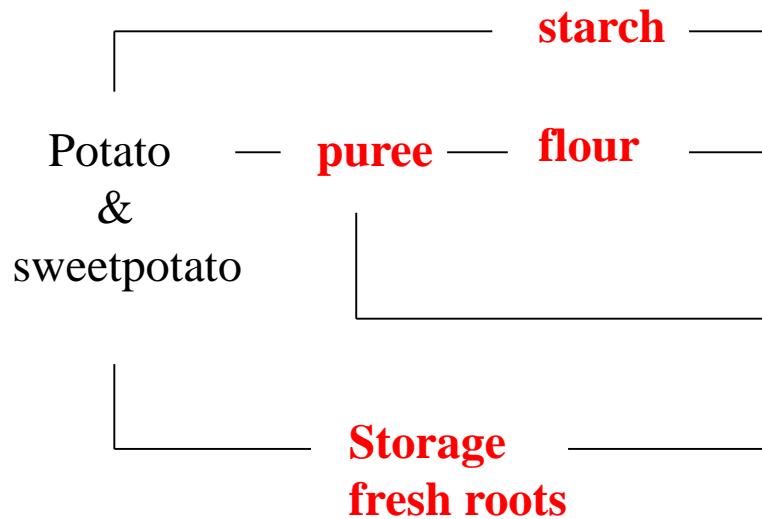
# sweet potato processing

## “Fresh roots-puree-flour” system



# sweet potato processing

## “Fresh roots-puree-flour” system



### Derived foods:

- New complex whole nutrition noodle (as table food)
- Extruded foods (re-structured rice, snack food, etc)
- **Baked foods (cookies, snack food, etc.)**
- Complex instant flour
- Potato and sweetpotato mud (ready food in powder etc.)
- French fry



# Flour and the derived products

- SP flour has been and will be more widely used in Foods, now in Sichuan Province, together with the Purple flesh flour development
- Healthy food with cure function(both orange and purple SP products)
- Can be as main food developments supported by government (noodle, bread etc.)

# OFSP-craker



**Cracker from potato & sweet potato**

(fresh roots, puree & yellow /orange flour)

# Craker from OFSP



## *Sweet potato candy*

- 1) fresh root → sugar soaking and boiling → drying
- 2) fresh root/flour → mixing-shaping → baking  
**(re-structured from fresh root, puree and flour )**

# OFSP-Chips

- 1) sweet potato cracker from fresh roots & flour
- 2) Fried chips from flour and fresh roots
- 3) Biscuit from fresh roots & flour



Fried chips from flour,  
puree and fresh roots  
of potato and sweetpotato



Biscuit from SP fresh roots, puree & flour

# sweet potato flour and puree

## *sweet potato flour*

- 1) **Energy & cost**      larger
- 2) **Nutrition**      loss some
- 3) **Flavour**      loss a little
- 4) **Derived use**      see later

5) Continuously separation for coarse fiber

## *sweet potato puree*

- small (no drying) save US\$  
by 100 , no sterilization if freezing  
full (especially fresh method)  
very few loss  
see later (**only extruding is partly  
limited**)





# Sweet potato flour

**There are four improved technology system for flour:**

1. Chip drying technology (by hot air house/box dryer)

1)fresh non-gelatinized flour, 2)semi-gelatinized flour, 3)full-gelatinized flour

2. Hot air current drying technology (granule flour products)

3. Drum drying technology (flake products)

4. Spray drying technology (beverage etc.)





# New technology for Sweet potato flour & Puree



## Method -1

Fresh —cut---steaming/microwave—hot air drying —powder—packing--products

## Method -2      Microwave +Current drying

Fresh —cut---steaming/microwave—puree—mix—hot air current drying —sieve—packing--products

# Sweetpotato flour production



Pre-treatment-1



Pre-treatment-2



Microwave



Hot air drying



Smashing

# Hot air drying for dehydrated chip and SP flour

1. Low investment, suitable for small and medium scale for chip, vegetables etc.
2. Energy saving by 30%, by inner heating
3. With temperature & RH control
4. Can be shaped/cut into chip, particle, stick



Drying house



Drying plate in drying house





## SP puree machine and its derived bread





# Products from sweet potato and puree





## SP derived rice from flour and puree



Complex rice by re-structured method from flour (by extruding)

# Derived products from Potato, Sweet-potato flour and puree



sweet potato noodle with wheat four (by mixing-shaping-drying)

# Orange Flesh & Purple SP noodle



Orange Flesh SP noodle





# Derived foods from purple SP flour

- Beverage (with milk)
- Steamed bread & noodle in family 面包、奶卷、粽子、窝头、面条等家用食品添加辅料
- Snack foods 小食品类（香酥薯片、油炸甘(紫)薯片、虾味脆片）
- Cakes (cookie, biscuit etc.) 糕点类（甘薯点心、饼干）
- Candy 糖果类（软糖、饴糖）
- Ice cream 冰淇淋类



# Dehydrated potato & sweet potato (with rice)



# Noodle processing technology

## ***1. method-1 Extruding and water tank gelatinizing method (popular)***

Suitable for SP starch with high sticky, the quality of tolerance is OK.

## ***2. method-2 Extruding method (popular)***

By extruder with single or double screws, the quality of tolerance is a little lower.

## ***3. method-3 Hot water gelatinizing method (popular)***

It is popular, the quality of tolerance is the best.

Type-1: Mixing & beating by manual (farmer small scale)

Type-2: Mixing & beating/extruding by machine (medium-to -large scale)

## ***4. method-4 Sheeting method (with best tolerance)***

It is the sheeting noodle machine line usually by large production scale, the quality of tolerance is the best, the noodle is straight.



# *1. The extruding and water tank gelatinizing method*

## **procedure:**

starch— mixing(ingredient)—extruding—cutting  
cooling—separating—freezing—drying—packing

## **product:**

- 1) Cooking noodle,
- 2) instant noodle

## **How to extend better products by this popular way:**

- 1) ingredient improvement(OF & purple SP, other additive and food materials etc)
- 2) steady freezing is very important for better quality





### *3. Hot water gelatinizing method*

starch—mixing—vacuum—extruding—cooling—freezing—  
separating—drying—packing

Noodle with good quality of  
tolerance, usually used in :

- 1) Cooking noodle
- 2) Hot pot noodle





**Sun drying**

**Hot air drying used for  
flour(chip) and noodle**





**Hot air drying used for  
flour(chip) and noodle**

**Sun drying**



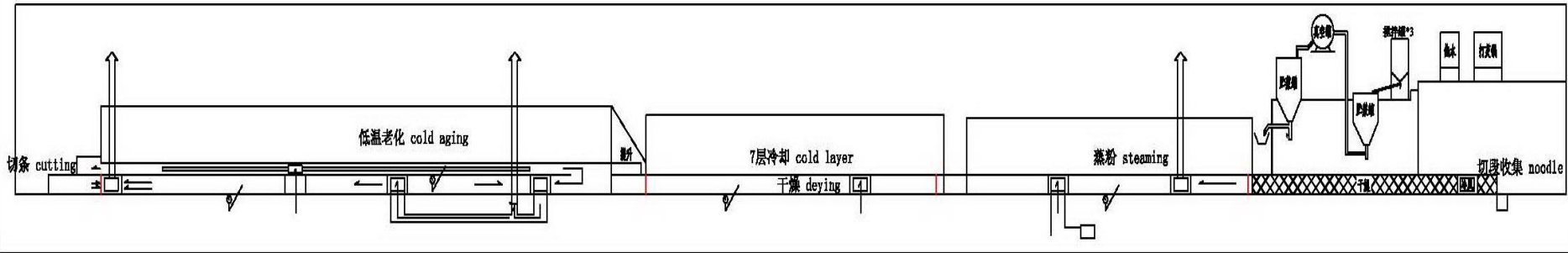


## 4. Sheeting method noodle procedure

Starch—mixing—sheeting—steaming—cooling—aging—cutting—shaping—drying—packing

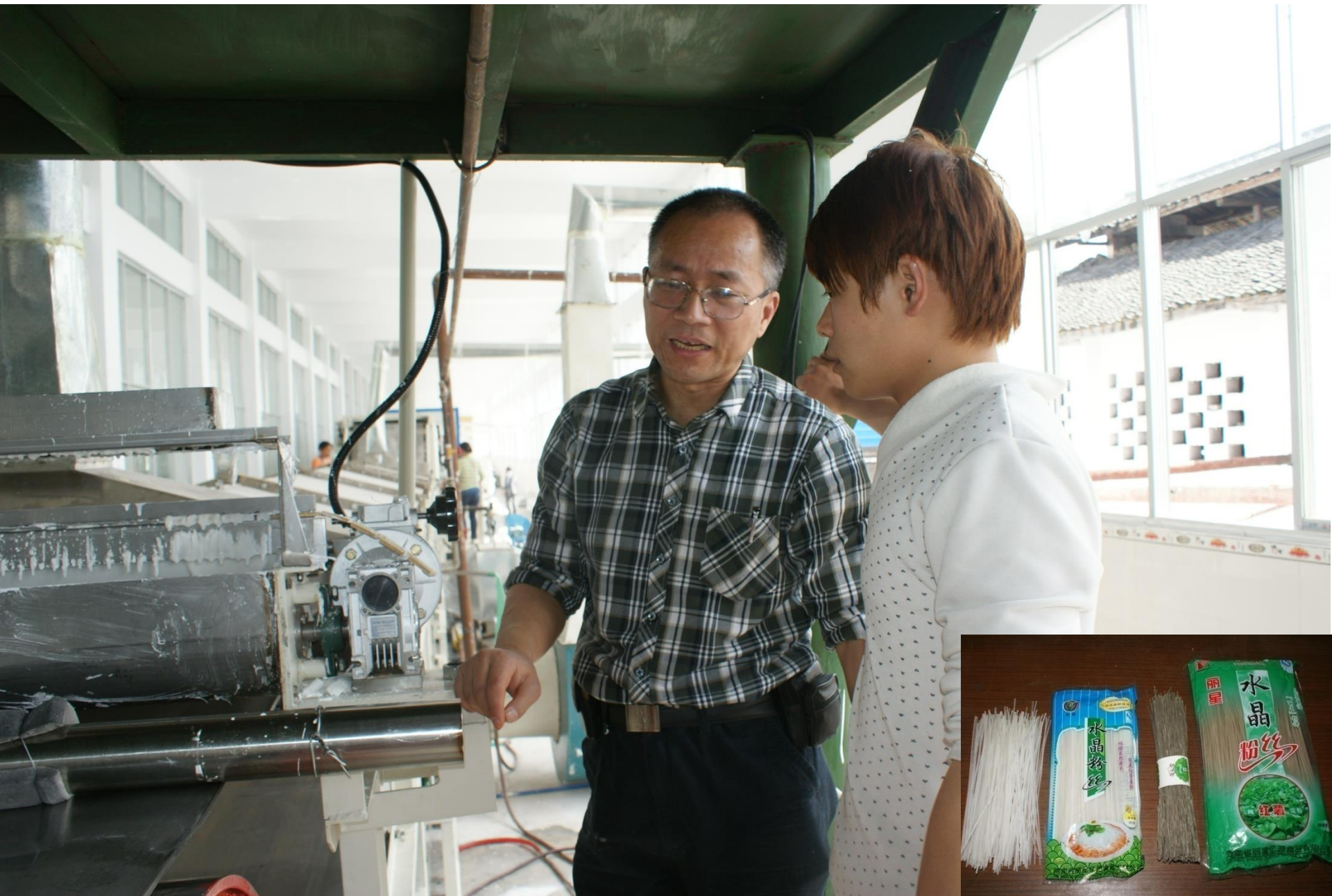
### Usual product:

- 1) Straight noodle in small package(cooking)    2) Instant noodle    3) Hot pot noodle(flat and broad)





# *Sheeting method noodle procedure: sheeting*



### *3. Hot water gelatinizing method*

starch—mixing—vacuum—extruding—cooling—freezing—  
separating—drying—packing

Noodle with good quality of  
tolerance, usually used in :

- 1) Cooking noodle
- 2) Hot pot noodle







Buck wheat Instant noodle



Sweetpotato Instant noodle



Sweetpotato Instant noodle



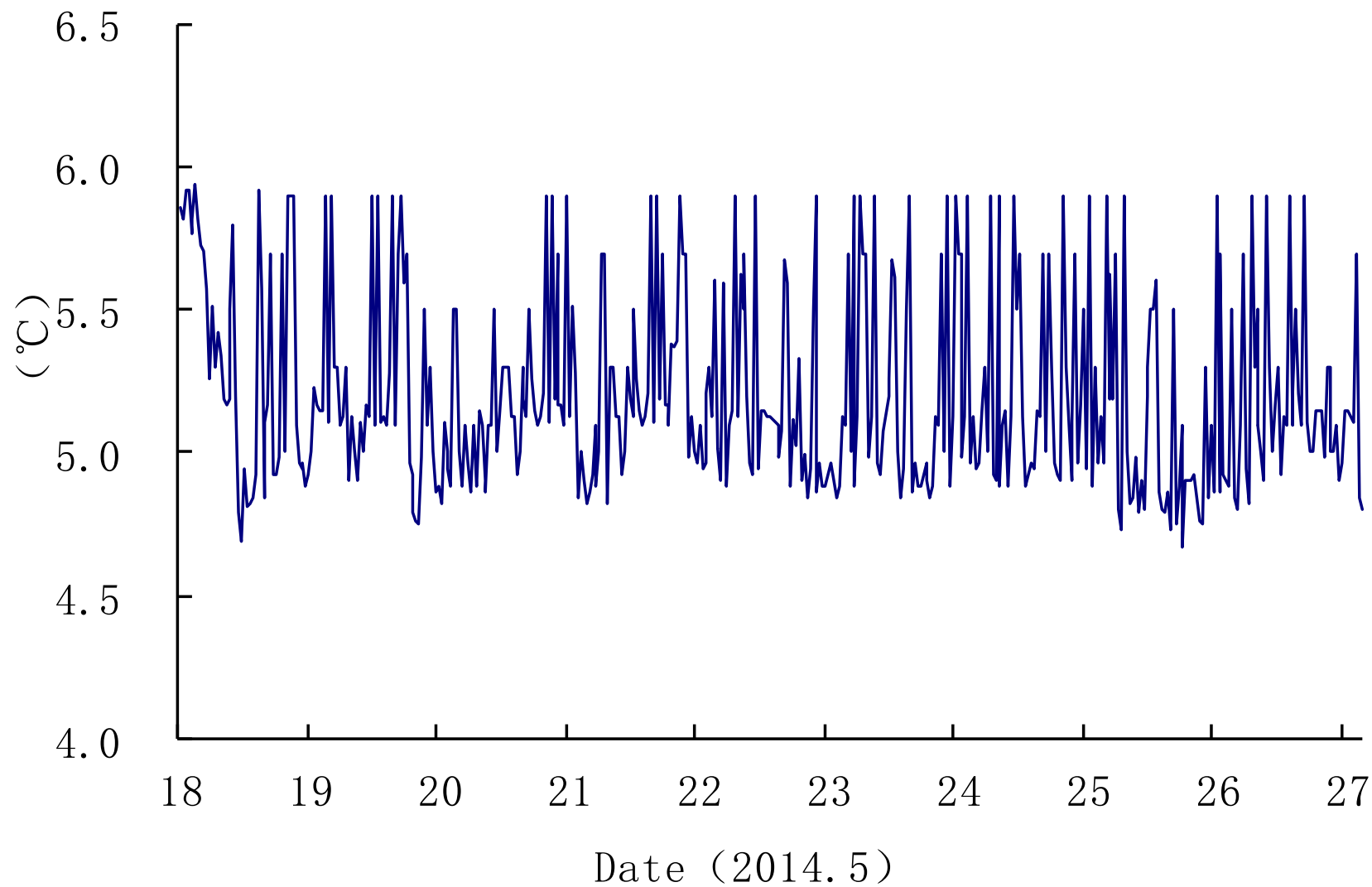
Potato Instant noodle by method 4

# Storage technology

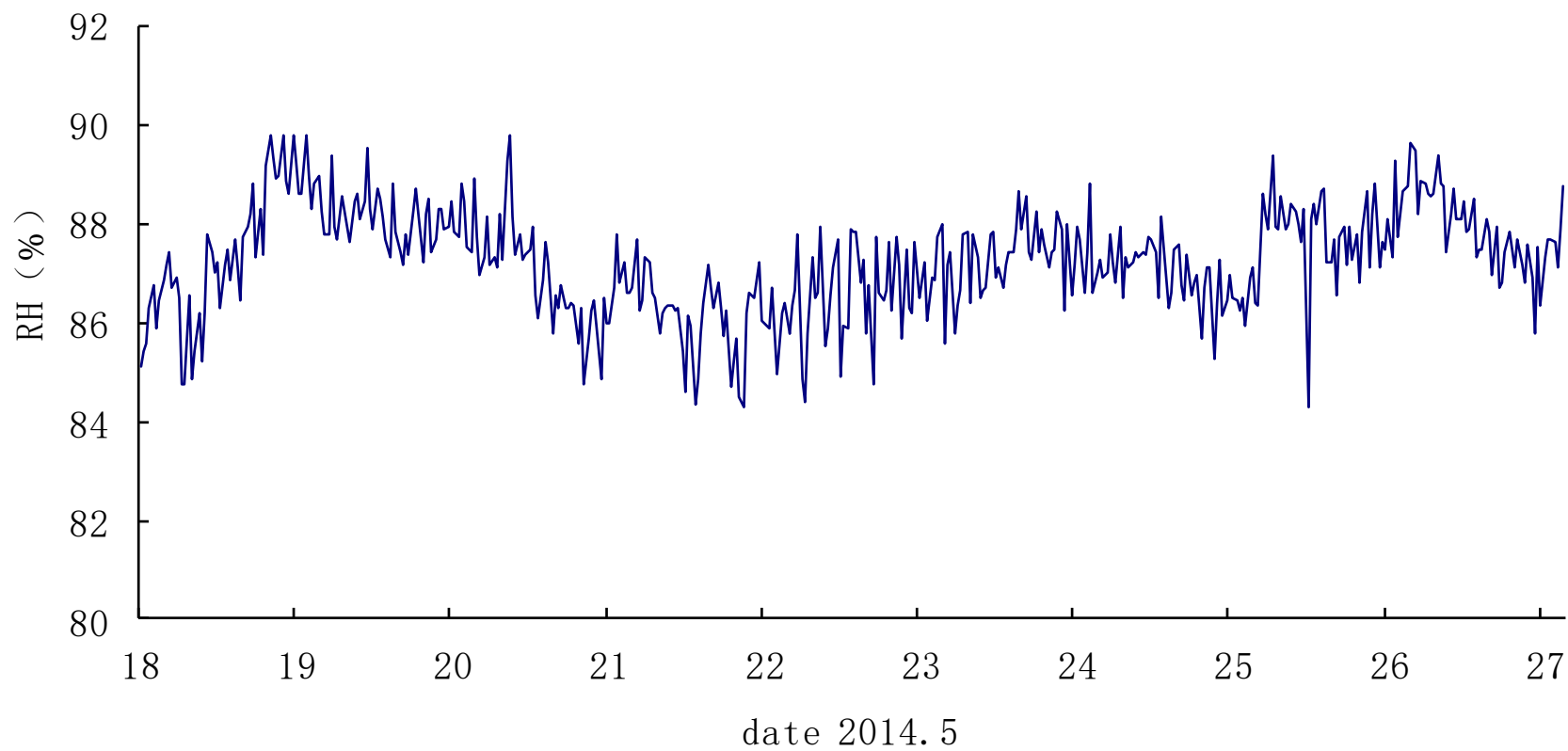
- Sweet potato & potato
- Fruit and vegetable storage
- Other agricultural products



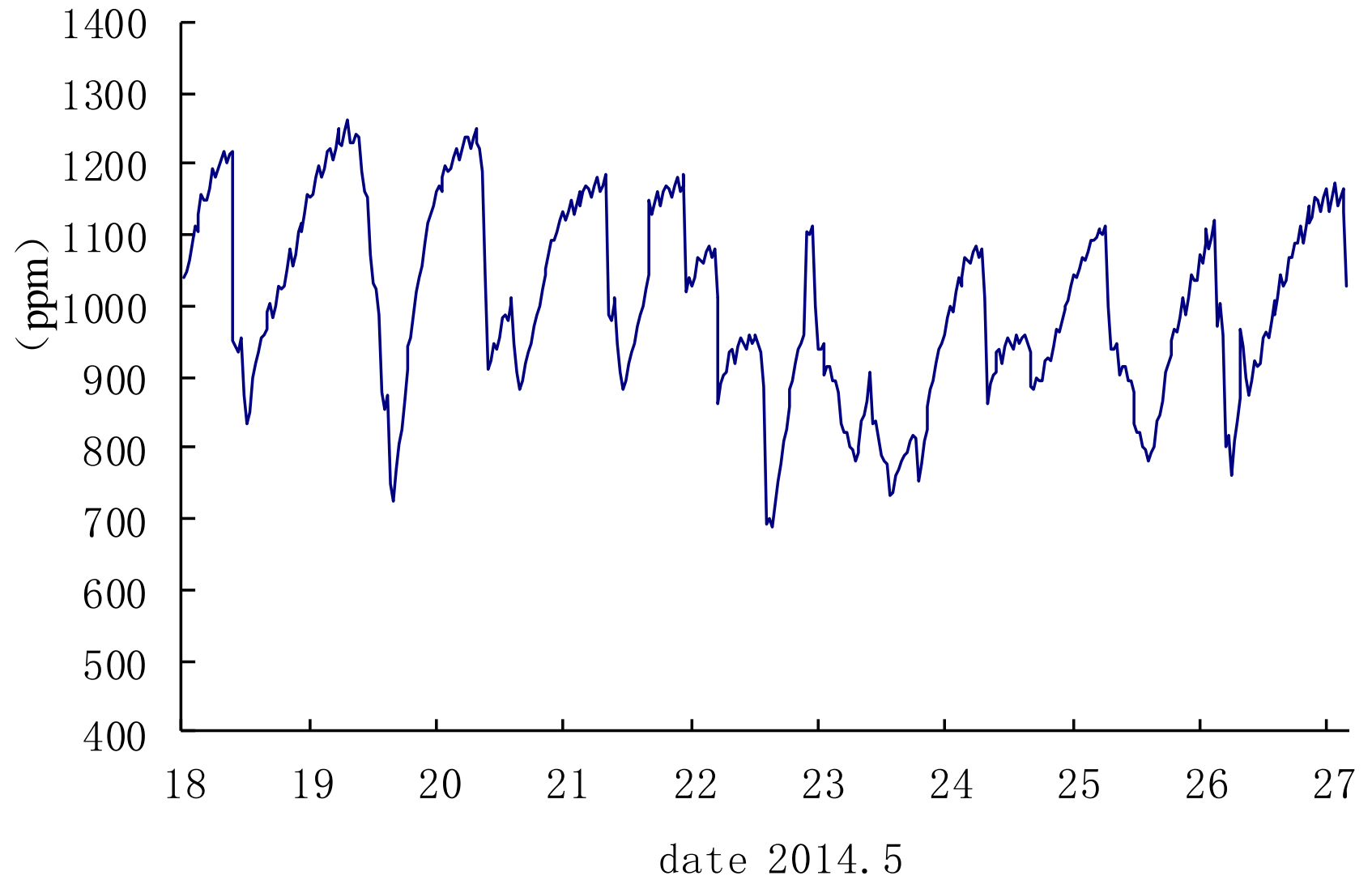
# Storage temperature



# Relative humidity



# CO2 changes in storage



# Potato and sweet potato storage

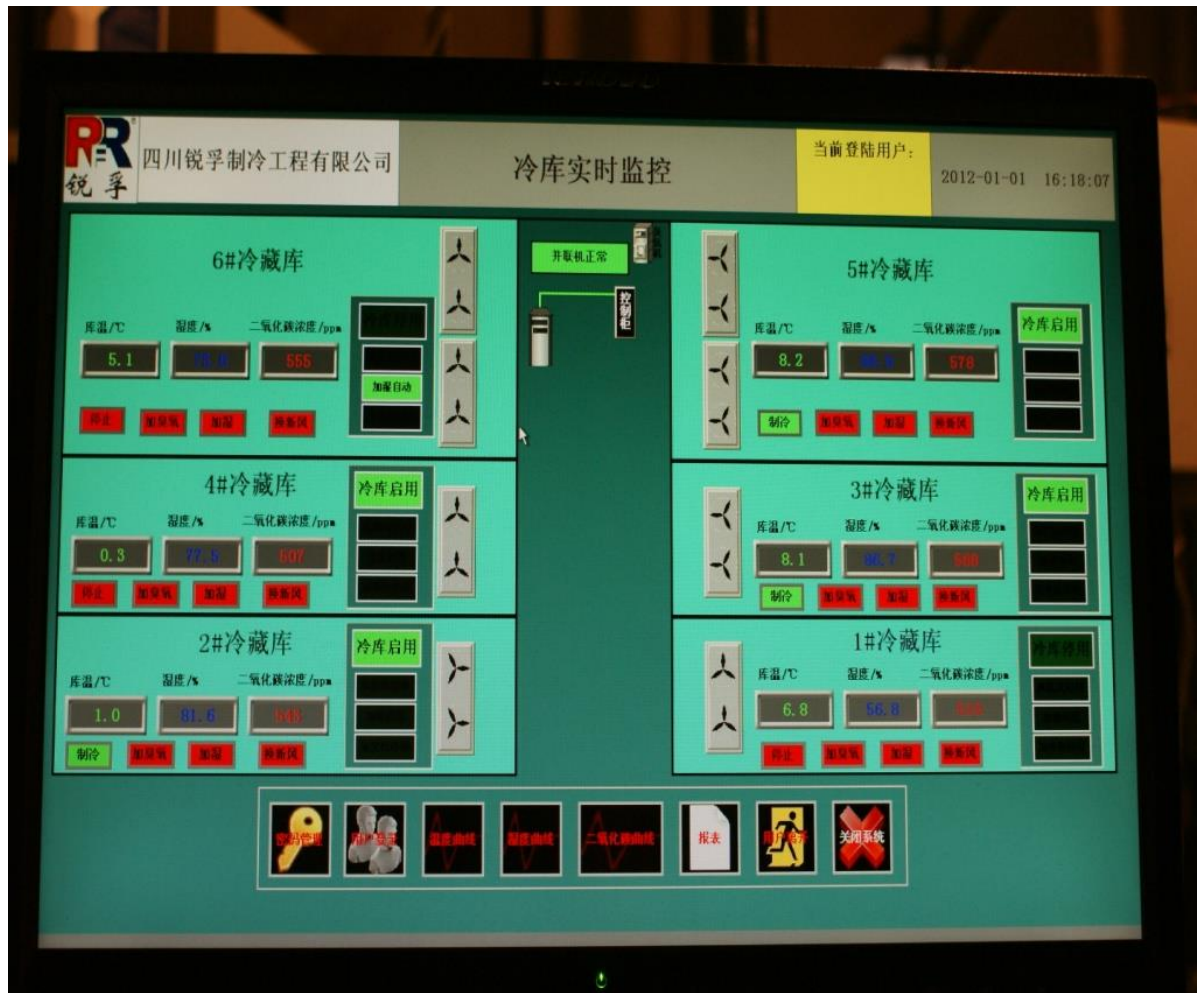
- Auto control for **temperature**;
- Auto control for **humidity**
- Auto **air ventilation** and control
  - 1) ventilating by pipes for carbon dioxide and oxygen according to :
    - a. outside condition of margin;
    - b. breathing of the materials.
    - c. testing
  - 2) **sterilization** (Ozone treatment etc.)
- Condensed water control in the initial storage stage
- Storage duration test (near-infrared ray test, etc.)
- Bio-test of material and storage condition control





# Storage R & D

- Root and tuber crops(potato, sweet potato )
- Fruits( Kiwi fruit, orange, apple, pomegranate, etc.)
- Vegetables (garlic, garlic shoot etc.)









# sweet potato flour and puree

## *sweet potato flour*

- 1) **Energy & cost**      larger
- 2) **Nutrition**      loss some
- 3) **Flavour**      loss a little
- 4) **Derived use**      see later

5) Continuously separation for coarse fiber

## *sweet potato puree*

- small (no drying) save US\$  
by 100 , no sterilization if freezing  
full (especially fresh method)  
very few loss  
see later (only extruding is partly  
limited)





# Sweet potato flour

**There are four improved technology system for flour:**

1. Chip drying technology (by hot air house/box dryer)

1)fresh non-gelatinized flour, 2)semi-gelatinized flour, 3)full-gelatinized flour

2. Hot air current drying technology (granule flour products)

3. Drum drying technology (flake products)

4. Spray drying technology (beverage etc.)



# Purple sweet potato flour



# New technology for Sweet potato flour & Puree

Fresh —cut---microwave—hot air drying —powder—packing--products



Method -2      Microwave +Current drying

Fresh —cut---microwave—puree—mix—hot air current drying —sieve—packing--products



# Sweetpotato flour production by chip drying



Pre-treatment-1



Pre-treatment-2



Microwave



Hot air drying



Smashing

## **Advantage of Hot air drying for chip into flour**

1. Low investment, suitable for small and medium scale for chip, vegetables etc.
2. Energy saving by 30%, by inner heating
3. With temperature & RH control
4. Can be shaped/cut into chip, particle, stick



Drying house

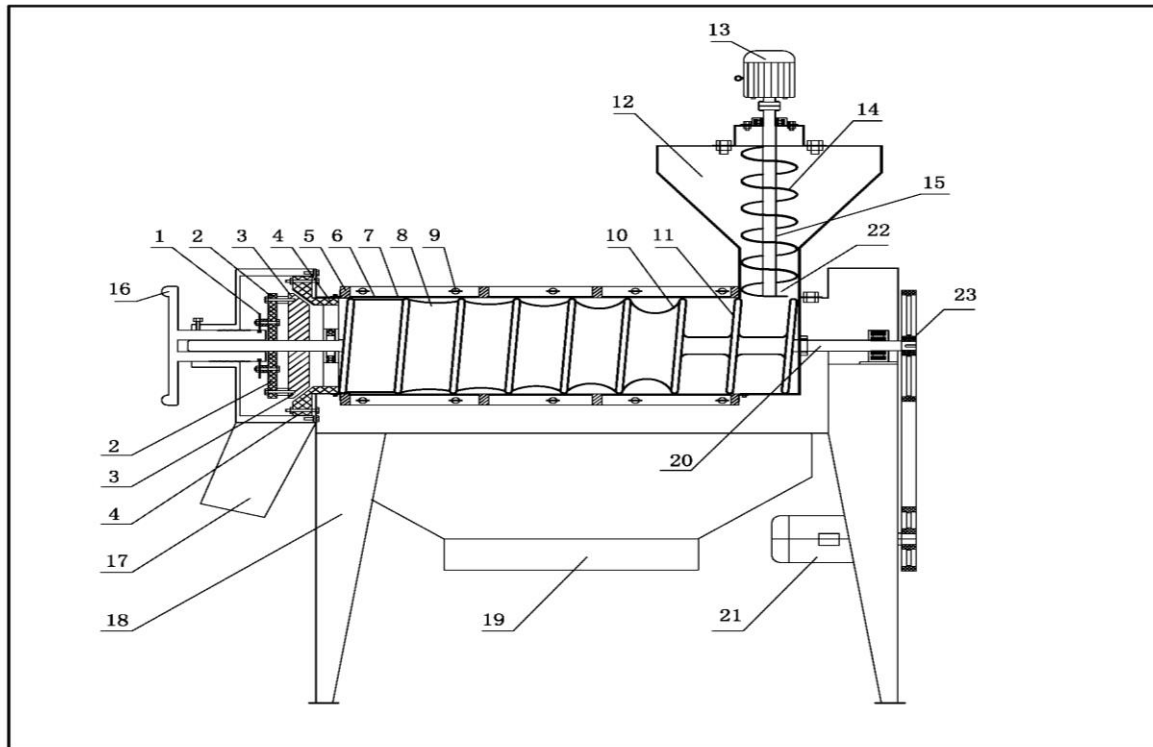


Drying plate in drying house

# New screwing machine for puree

## Advantages

- Gelatinization (65-70%)
- Continuously operation
- Water control ( $\leq 70\%$ )
- Fine degrees ( $\leq 0.5\text{mm}$ )
- Coarse fiber control







## puree machine and its derived bread



# Derived products from Potato, Sweet-potato flour and puree



Sweet-potato biscuit  
(by baking)



purple sweet potato noodle  
with wheat flour (by mixing-shaping-drying)



Dumping flour from sweet potato  
and waxy rice (by mixing)



Complex rice by re-structured method  
from flour (by extruding)



# Purple sweet potato beverage





# Purple sweet potato noodle



# Dehydrated potato & sweet potato (with rice)



# Derived foods from purple SP flour

- Beverage (with milk)
- Steamed bread & noodle in family 面包、奶卷、粽子、窝头、面条等家用食品添加辅料
- Snack foods 小食品类（香酥薯片、油炸甘(紫)薯片、虾味脆片）
- Cakes (cookie, biscuit etc.) 糕点类（甘薯点心、饼干）
- Candy 糖果类（软糖、饴糖）
- Ice cream 冰淇淋类





# Products from sweet potato and puree



# starch processing system

**Coarse starch** (medium scale or small scale by farmers)



**Refined starch** (medium and large scale)



**Series products**

<b>Wheat Instant noodle</b>	<b>40%</b>
<b>Starch noodle</b>	<b>35%</b>
Food industry and Cooking	15%
Family cooking	8%
Modified starch	2%

*Improved starch procedure:*

Fresh root---wash---smashing--filtration---  
“sour liquid” ---deposit---refining---deposit-  
--exchange water---dehydration---drying



Starch for cooking and food processing



biscuit made from wheat flour and starch



Starch dumpling

# Key products and technologies

## 1. New technology for flour and puree

- Sweet flour by key technology of energy-saving drying from IAPST of SAAS has won the Sichuan Provincial Science Prize and 5 Chinese patents, and it is expected to play the profound influence to new stage for potato and sweetpotato flour processing.
- The series of derived new products from flour and puree can be preserved longer and developed widely.

## 2. New instant noodle and snack food technology

- The new Nutrition and the traditional noodle with best quality of tolerance is suggested to be developed from the new flour/(puree), starch and other auxiliary materials.
- The new snack foods derived from the flour and puree, with special flavour, and together with fresh roots.

## 3. Storage technology and its facility

- Set up the new comprehensive storage facilities/house for sweet potato, with the Auto test/show and control function for temperature, humidity, gas, etc.



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***Vacuum frying products***  
***(chips, sticks)***

## 2. *Vacuum frying products (chips, sticks)*

### Procedure

Fresh roots → washing → peeling → cutting → pre-treatment → frying  
→ seasoning → packing

### Feature of technology and its products :

- 1) made from fresh roots
- 2) lower temperature
- 3) better quality (color, crisp, nutrition)
- 4) can be used scale for Potato, sweetpotato and many fruits and vegetables in medium and small production





Vacuum frying machine









Potato

Sweetpotato



Sweet potato



Potato chip

# Snack foods by vacuum frying method



Potato



Potato



Broad bean



# Snack foods-1



## Re-structured snack food by extruding

(from potato & sweet potato flour of purple and yellow color)



**Cracker from potato & sweet potato**  
(fresh roots, puree & yellow flour)





## Snack foods-2

### *Sweet potato candy*

- 1) fresh root → sugar soaking and boiling → drying
- 2) fresh root/flour → mixing-shaping → baking



Sweet-potato candy  
(re-structured from fresh root,  
puree and flour )

# Snack foods-3

- 1) sweet potato cracker from fresh roots & flour
- 2) Fried chips from flour and fresh roots
- 3) Biscuit from fresh roots & flour



Fried chips from flour,  
puree and fresh roots  
of potato and sweetpotato



Biscuit from SP fresh roots, puree & flour

# THANK YOU !

Institute of Agro-products Processing Science and  
Technology of Sichuan Academy of agricultural Sciences  
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