

## The Status of Root and Tuber Production, Utilization and Marketing in Japan



*Katsumi Komaki*

National Institute of Crop Science  
National Agricultural Research Organization  
Japan



## Production of Root and Tuber Crops in Japan

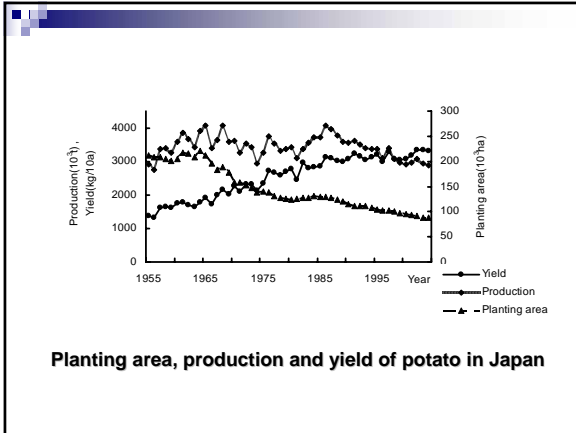


	Planting area (ha)	Production (t)
1. Potato	87,200	2,888,000
2. Sweetpotato	40,300	1,009,000
3. Taro	15,700	184,500
4. Japanese yam	8,640	197,900
5. Konjac	4,890	70,800

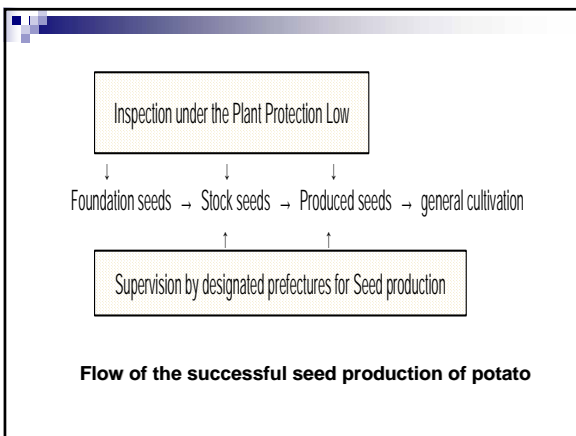
## Production and Consumption

### Potato production

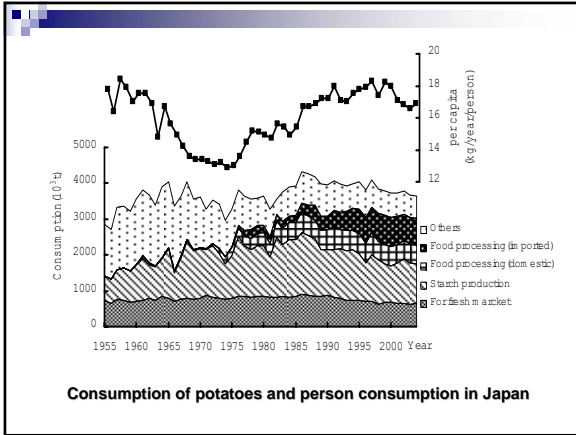
- Planting area was halved from approximately 200,000 ha in 1960 to 90,000 ha in 2002.
- However, production has remained unchanged at approximately 3,000,000 tons. This is due to an increase of yield from 18 to 33 t/ha.



- ### Potato production
- Planting area was halved from approximately 200,000 ha in 1960 to 90,000 ha in 2002.
  - However, production has remained unchanged at approximately 3,000,000 tons. This is due to an increase of yield from 18 to 33 t/ha.
  - **Reasons for yield increase**
    - Establishment of the multiplication system for disease-free seed potatoes and the seed potato quarantine system.
    - Development of high yielding cultivars
    - Use of cheap chemical fertilizer and agricultural chemicals
    - Progress of cultivation management techniques, such as proper fertilizer application, and pest and disease control

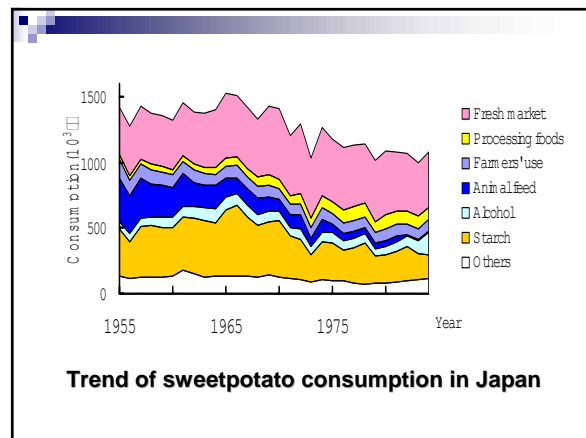
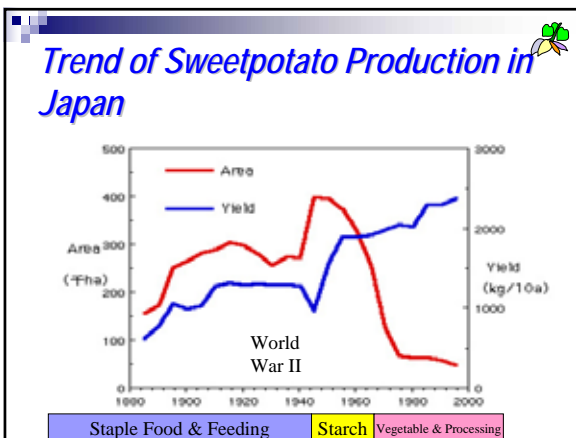


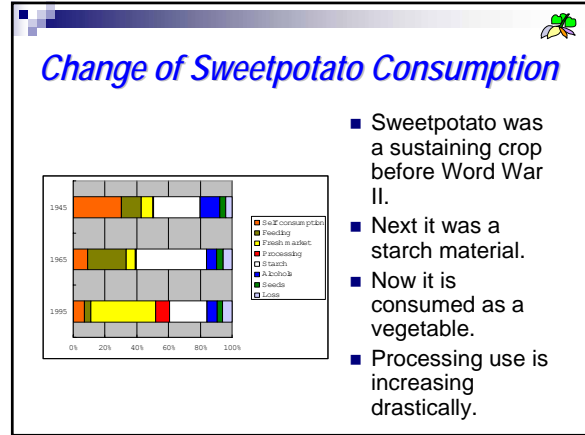
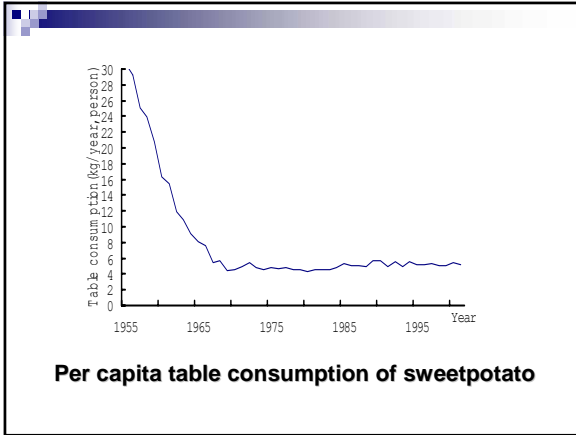
- ### Potato consumption
- Japan's per capita annual consumption
    - More than 17 kg until around 1960
    - As the potato's role changing from a staple food to a vegetable, decreased to ca. 13kg.
    - Now, 17-18 kg due to the increase of the consumption of processed products, such as potato chips, frozen fried potatoes, frozen croquettes and packaged salads .
  - Increasing processing food consumption, import of processed materials is rapidly increasing.
  - High quality and yielding cultivars are strongly required to encourage use of the domestic potato.



### Sweetpotato

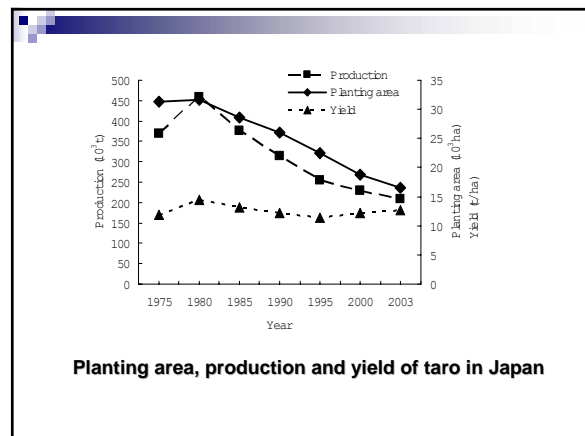
- In 1940's the acreage of SP reached at **400,000** ha. At present it is only **40,000** ha.
- In the 1940's, **40%** was consumed as a **staple food**, **20%** for **starch production**.
- The consumption for **starch** peaked at **50%**, but now **50%** of SP is consumed for the **table use**.
- **Food processing** is increasing **over 10%** of the total consumption.





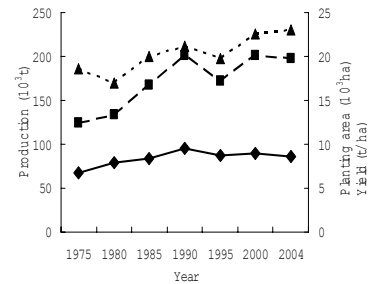
**Taro**

- Planting area was 30,000 ha in 1975, and now halved to 16,000 ha.
- Production decreased from ca. 400,000t to 200,000t, since yield has not been improved, ca. 12-13t/ha
- Taro is usually used for a traditional boiled dish.
- Before 1990's no taro was imported, however, more than 30,000t at present, which were more than 10% of total consumption in Japan, are imported mostly from China.



## Japanese yam

- Planting area is 7,000-8,000 ha, which does not change in these 30 years.
- Production has been gradually increasing up to 200,000t.
- It is likely due to the limited import and yield improvement from 17-18 t/ha to 22-23 t/ha.
- Japanese yam has very sticky root flesh, and is usually grated and eaten by putting it on the boiled rice or as noodle mixing with wheat or buckwheat flour.



Planting area, production and yield of yam in Japan

## Konjac

- Present planting area and production are ca.5,000 ha and ca. 70,000 t, while they were ca. 17,000 ha and 110,000 t in 1970, respectively.
- Yield is sharply increasing because of
  - Development of high yielding cultivars
  - Development of cultivating technology, such as proper pest and disease control.
- Konjac is processed to konjac foods, using mannan accumulated in its tuber.



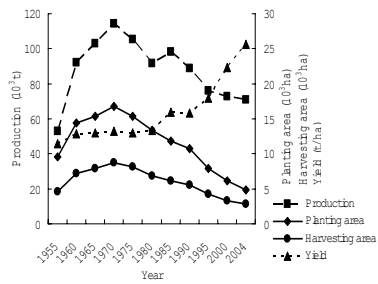
Konjac plant



Konjac tuber



Various konjac foods



Planting area, harvesting area, production and yield of konjac in Japan

**Research activities  
in Sweetpotato**

### *Direction of research to lift up sweetpotato consumption*



- Focus on the processing use.
  - Respond to the consumers' oriented demand.
- ↓
- Development of new utilization system
  - Improvement of cultivation system reducing production cost

### *Development of new utilization system promoting consumption*



- Storage root and top of sweetpotato contain various chemical components, and some of them have physiological functions.
- New utilization system has been developed analyzing their nature and the varietal differences of their contents.

### *Pigments*

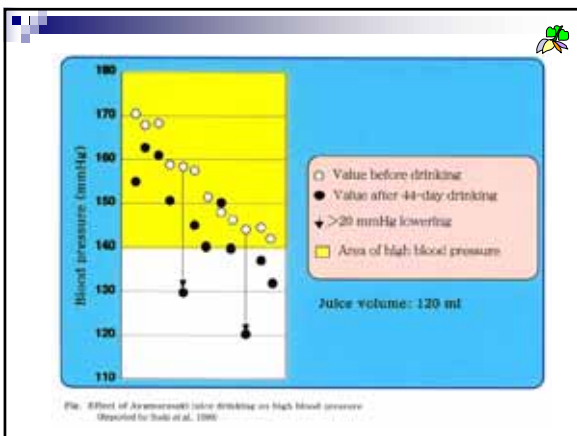
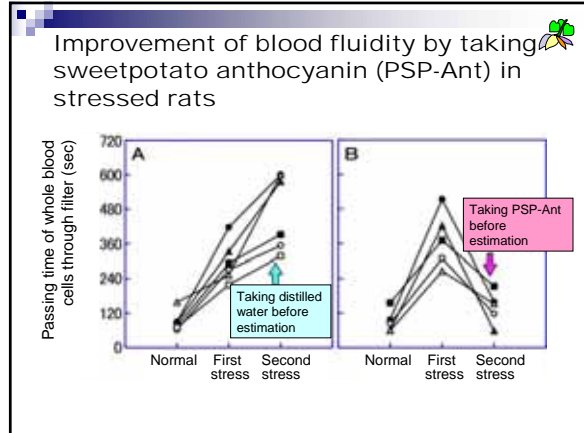
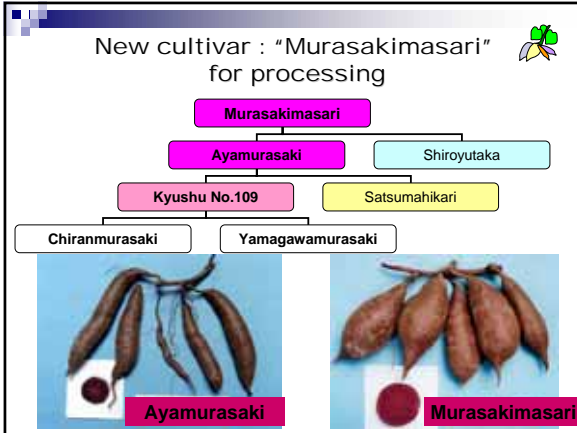


- Sweetpotato has three kind of pigments
  - Anthocyanin
  - Carotenoid
  - Flavonoid

### *Anthocyanin*



- Color **quality** and **stability** is higher than that of red cabbage.
- Sweetpotato anthocyanin has important **physiological functions** for our health.



- Development new products using colored sweetpotato*
- Collaboration with industry is essential.
  - **Flour**: Drying process, especially in orange fleshed cultivars
  - **Juice**: Decomposition of starch and dextrin
  - **Alcoholic beverages**: Decompose starch to sugars and the yeast fungus for fermentation
  - **Pottage soup and croquette**





## Starch

- Sweetpotato for starch production have a starch content of about **25%** on a fresh basis.
- New cultivars, **Konahomare** and **Daichi-no-yume**, with starch content of **29-30%** have released.
- Sweetpotato has a wide range of **amylose content** and starch **retrogradation**.
- **Quick Sweet** having low pasting temperature of starch was developed.

New cultivar : "Konahomare" and "Daichinoyume" for starch production

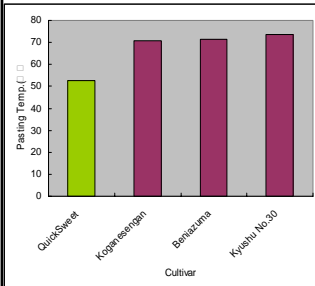
	Konahomare	Daichinoyume	Kogane-sengan
Root yield (t/ha)	48.2(124)	44.7(115)	38.8(100)
Dry matter content (%)	39.1	38.8	36.8
Dry matter yield (t/ha)	18.9(132)	17.3(121)	14.3(100)
Starch content (%)	29.2	28.5	26.5
Starch yield (t/ha)	14.1(137)	12.7(124)	10.3(100)

Note: cultivation under mulching condition(1995-99,2002)

## Starch of "Quick Sweet"

- We found a breeding line (Kanto 116) having abnormal starch granule.
- They are cracked on the hilum.
- This line has been released as "Quick Sweet".

### Pasting temperature and gelatinization properties of starches from "Quick Sweet"



- Normal sweetpotato starches become paste or gelatinize around 70 ..
- "Quick Sweet" starches become paste around 50 ..
- These starch properties are quite unique among sweetpotato starch.

\* Pasting temperature of 7% gel (w/v)

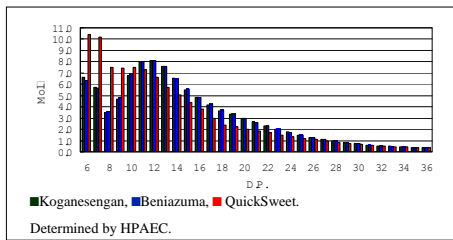
### Starch content and amylose content of "Quick Sweet"

Cultivar or line	Starch content (%)	Amylose content (%)
Quick Sweet	25.7	16.6
Koganesengan	20.9	16.5
Beniiazuma	25.1	16.2
Kyushu No.30	17.3	17.6

Starch contents were determined by the sedimentation method.  
Amylose contents were calculated from the blue values.

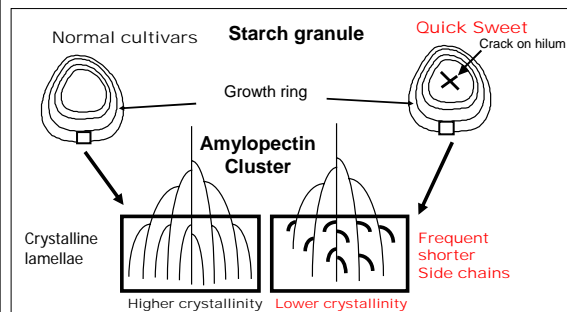
- Starch content and amylose content of "Quick Sweet" are rather normal.
- Unique starch properties of "Quick Sweet" are not caused by shift of amylose content.

### Chain-length distribution of amylopectin of "Quick Sweet"

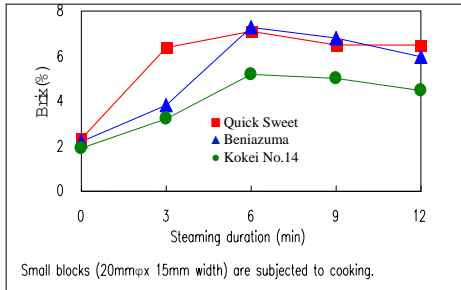


- "Quick Sweet" amylopectin has a higher proportion of short chains (DP 6 - 11) and a lower proportion of chains between DP 12 - 28 than the normal amylopectin of sweetpotato.
- This change in amylopectin is thought to be the reason for the unique starch properties of "Quick Sweet".

### Amylopectin Structure of "Quick Sweet" Starch

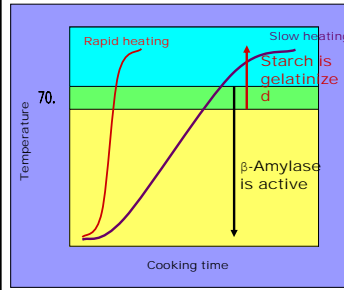


### Changes in brix during steam cooking of "Quick Sweet"



- "QuickSweet" can be cooked in shorter steaming time, probably due to its lower starch pasting temperature.

### How can we get sweet sweetpotato even after quick cooking ?



Only under the green temperature, maltose is produced.

- Sweetness of sweetpotato is derived mainly from maltose which is caused by  $\beta$ -amylase activity.
- $\beta$ -amylase acts on gelatinized starch.
- Normal sweetpotato starch is gelatinized above 70..
- Sweetpotato  $\beta$ -amylase loses the activity around 70..
- Starch with lower gelatinization temperature or heat tolerant  $\beta$ -amylase is necessary for quick and sweet cooking property.

### Improvement of cultivation system reducing production cost

- The average storage root yield of sweetpotato is 25 t/ha, and around 30 t/ha in the case of starch use at present.
- Sweetpotato production requires about 700 hrs/ha for starch use and more than 2000 hrs/ha for table use.
- Raw material price must be cut down in the processing company for stable management.

### Increase of Storage Root yield

- To increase the productivity: high yielding cultivar; chemical fertilizers; mulching with plastic film.
- "Kokei No.14" and "Beniazuma" for table use, "Koganesengan" and "Shiroyutaka" for starch use
- Nitrogen of 30 and 60 kg/ha for table use and starch production, respectively, and double amount of potassium promise high yield.
- Hill mulching by plastic film keeps the soil temperature, moisture and hardness, and controls weeds

## Mechanization



- Working hours: 30% for raising and planting  
40% for harvesting
- Mechanization of harvesting has already developed, but not cutting and planting machine of seedlings yet.
- Direct planting of seed roots is to be practical and promising than developing the planting machines of seedlings.
- Adaptability for direct planting were evaluated.
- Full mechanization is expected to reduce the total working hours 150 hrs/ha.

## Direct planting of seed roots



Murasakimasari



## Ending Remarks



Processing use is increasing in potato and sweetpotato.

Collaboration study with industry is important to develop new demands.

***Thank you for your attention!***