Sweet Potato and Its Breeding Efficacy

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Sweet potato in Japan

Sweet potato was introduced in Japan about 350 years ago. It was popularized as a famine relief crop because of its resistances against typhoon and drought, and its area spread to 300 thousand hectares up to the end of the 19th century. Sweet potato had discharged the important service to solve the food shortage from the beginning of the 2nd World War to the time immediately after the War, and its area increased to 440 thousand hectares in maximum as shown in Fig. 1. Although the acreage decreased with the dissolution of the food shortage, the area over 350 thousand hectares was maintained for about ten years after that, to meet the increased demand as the raw material of starch. The liberalization of sugar import and the increase of cornstarch production in these days have made the glucose industry using sweet potato starch unprofitable. Therefore, the farmers income from sweet potato has become unstable, and the acreage of sweet potato has decreased to about 250 thousand hectares. Tuber yield per hectare was about 13 tons till the time of the 2nd World War, but it rapidly increased after the War and reached to about 20 tons per hectare today. This was owing to the popularization of the improved varieties (Fig.6) with the improved cultivation method. Amount of the total product, as shown in Fig. 1, increased with the increase of acreage after the War, and it was kept up about 6 million tons owing to the increase of the yield per unit field area in spite of the decrease of acreage. The total amount of sweet potato production in Japan will be maintained about 6 million tons for the time being.

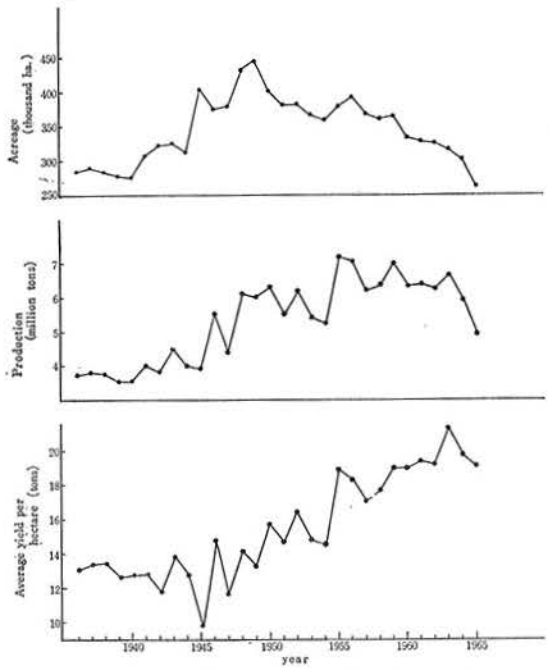

Fig. 1. Trend of acreage, production and average yield per hectare of sweet potato in Japan.

Sweet potato was mainly cultivated for the self supply food of farmers before the 2nd World War (Fig. 2). As mentioned above, it had discharged the important service to solve the food shortage from the beginning of the 2nd World War to the time immediately after the War. At present, the main consumption of sweet potato has changed into the raw material of starch (about 40 % of the total product) and next into the feed for livestock (about 25% of the total product). About 55 % of the total product have been cultivated for selling

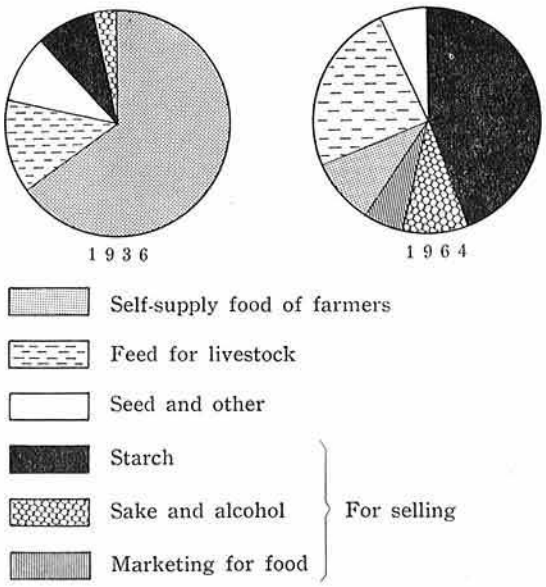

Fig. 2. Proportion of consumption of sweet potato
Note. Marketing for food in 1936 is included in self-supply food of farmers.

The production of sweet potato starch in Japan, as shown in Fig. 3, has rapidly increased after the 2nd World War. This is mainly owing to the development of the glucose industry using sweet potato starch. The great part of sweet potato starch is used for such a sweet taste material as starchy jelly and glucose.

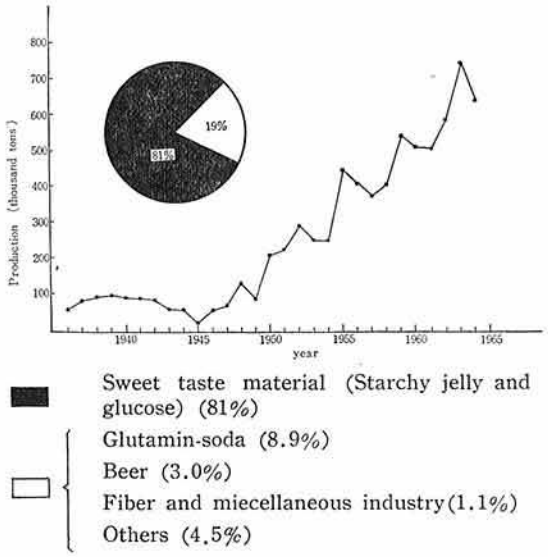

Fig. 3 Trend of production of sweet potato starch and its consumption (1963).

Breeding experiments

The crossed seeds were introduced for the purpose of the breeding experiments before the 2nd World War from Ryukyu where sweet potato naturally flowered. After the War, the crossed seeds have been obtained in the green house kept warm by hot spring in Ibusuki Experiment Farm of National Kyushu Agricultural Experiment Station. The grafting method or the method combining the short day treatment with the grafting have been adopted for arftificial blooming. Evening glory plants or morning glory plants have been used as stock plants for the grafting. Morning glory of the dwarf type, "Kidachi-asagao" had strikingly high sensibility to the short day. Therefore, if sweet potato varieties were grafted on this morning glory with some leaves, even the non flowering type of sweet potato varieties could flower.

By the above method a total of approximately 130,000 seeds were produced for 1966. About 33,000 to 43,000 of these seeds were distributed to Sweet Potato Breeding Centers in Chiba, Fukuyama and Kumamoto respectively. The seeds could thoroughly germinate by sowing after the treatment with concentrated sulphuric acid for an hour and thorough washing, although the seeds couldn't absorb water and failed to germinate when they were sown without the treatment.

In former times, the purpose of the breeding experiments was aimed at high yield and good quality as the food. Recently, however, the great emphasis is put on high yield and high starch content as the raw material of starch. In the 1st to 2nd year tests of the selection which aim at the raw material of starch, the plants with unfavourable state and shape of tuber, the plants with the tuber of the bad sprouting habits and the plants with the tuber of the low yield or the low starch content are eliminated. The evaluation of the starch content of tuber is roughly done by the hardness or the specific gravity of tuber.

In the 3rd to 5th year selection tests, that is the preliminaly yield tests and the per-

formance tests, yield and starch content of the tuber are strictly evaluated. The test of starch content of tuber is estimated by the Whirling Blender method. The adaptability for much or less manuring, the adaptability to the early digging and the tolerance to black rot disease and root-knot nematode are also tested. Furthermore, the tests for special characters, that is cool tolerance, drought tolerance, root rot nematode tolerance and adaptability to the late planting are performed in each special place.

The local lines selected in the performance tests are tested on the actual places of the producing districts. The lines selected in this tests are propagated as the registered varieties and they ars presented to the cultivation of farmers as the recommended varieties.

Breeding effects

Progress in the breeding tests has exceedingly contributed to increasing the tuber yield and its starch content, which are the most important factors as the raw material of starch industry, and to controlling black rot disease, which brings serious damage to sweet potato production in Japan.

Fig. 4 showed the breeding effects on yield and starch content of the tuber. (A) in figure showed the results in Chiba Breeding Center. The local variety with the higher starch content had the little tuber yield, on the other hand, the ones with the higher tuber yield had the low starch percentage. Therefore, the starch yields per unit field area of the local varieties were low. Yields and starch contents of the tuber in the old registered varieties increased more than those of the local varieties. The recent registered variety, "Tamayutaka", was very productive and its tuber had comparatively higher starch content. Another recent registered variety "Konasengan", had much yield notwithstanding high starch content of the tuber. Therefore, the starch yields per unit field area of these varieties were much larger than those of the old registered varieties. (B) in figure showed the results in Kumamoto Breeding Center. The results in Kumamoto was also seemed to be the same as in Chiba. The starch contents of tuber in Kumamoto, however, were relatively higher than those in Chiba, because the growth period of sweet potato in Kumamoto was longer owing to warm weather compared with that in Chiba.

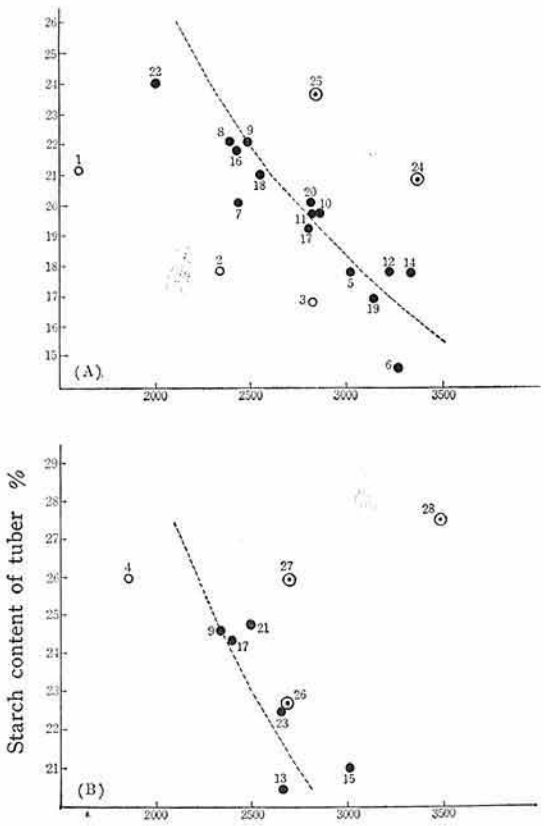

Fig. 4 Breeding effects on yield and starch content of sweet potato tuber.

Note.

1) (A) Yield test under the standard cultivation in Chiba Breeding Center (1938～1965)
   (B) Yield test under the standard cultivation in Kumamoto Breeding Center (1958～1965)
2) Varieties
   local varieties ……○
   1. Beniaka 2. Taihaku
   3. Oiran 4. Genji

Old registered varieties ……●

5. Okinawa No. 100 6. Ibaragi No. 1
7. Gokoku-imo 8. Norin No. 1
9. Norin No. 2 10. Norin No. 4
11. Norin No. 5 12. Norin No. 6
12. Norin No. 7 14. Norin No. 8
15. Norin No. 9 16. Norin No.10
17. Kuroshirazu 18. Chihaya
19. Shirosengan 20. Okimasari
21. Nakamurasaki 22. Kurimasari
23. Benisengan

Recent registered varieties ……◉

24. Tamayutaka 25. Konasengan
26. Satsuma aka 27. Ariake-imo
28. Kogane sengan

3) …… Iso-yield curve of starch with the variety "Norin No. 2"

The local varieties were all susceptible to either black rot disease or root-knot nematode as shown in Fig. 5. There were the improved varieties which were resistant to one of these damages and tolerant to the other although there was no variety combining both resistances. The similar relationship was observed concerning the resistances to root-knot nematode and root rot nematode. The variety which combined both resistances such as "Satsuma-aka" was found in the recent registered varieties.

The other characters such as sprouting habit, storage habit and adaptability to early digging etc. also markedly improved.

Fig. 6 showed the trend of acreaga planted to the main varieties of sweet potato. The shaded area showed the changes of the improved varieties. About 95 % of the total area planted to sweet potato in 1940 were the local varieties. At present, however, the improved varieties bred by crossing hold nearly 90 % of the total sweet potato area. Some characters of the main varieties are shown in Table 1.

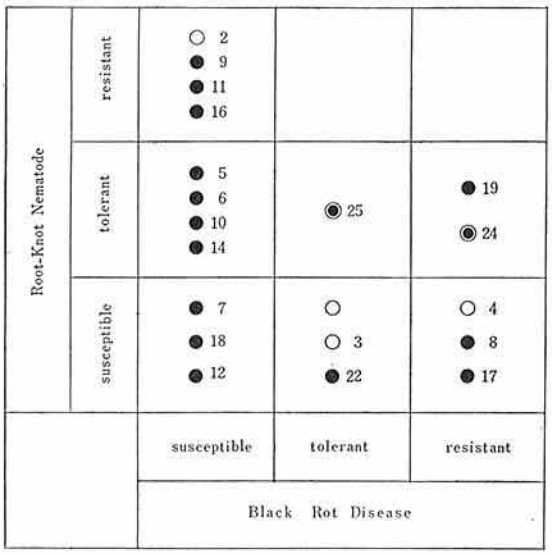

Fig. 5 Breeding effects on the resistances against black rot disease and root-knot nematode in sweet potato. Varieties are the same as in Fig. 4

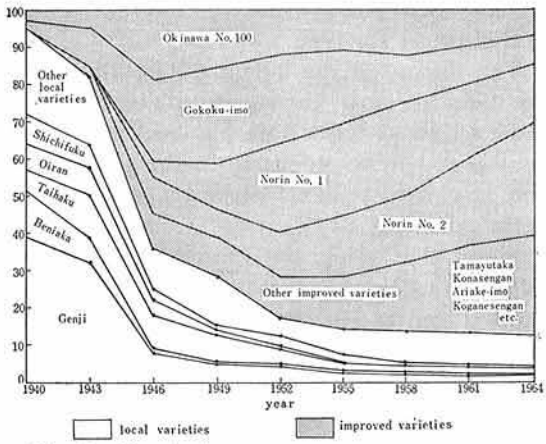

Fig. 6 Trend of acreage planted to main varieties of sweet potato.

Table 1. Some characters of the main varieties

Varieties	Origin	Registered year	Tuber				Use
			Yield (kg/10a)	Starch (%)	Skin colour	Flesh colour	
Beniaka	local variety	—	1611	21.2	purple red	yellow	food
Taihaku	〃	—	2333	17.9	〃	white	〃
Genji	〃	—	1830	25.8	light pink	light yellow	food and starch
Okinawa No. 100	Shichifuku × Chosyu	1934	3030	17.9	light red	yellow white	starch

Gokoku-imo	Genki × Shichifuku	1938	2477	20.3	light brown	light yellow	food and starch
Norin No. 1	Genki × Shichifuku	1942	2405	22.1	red brown	yellw white	food
Norin No. 2	Toshida × Okinawa No. 100	1942	2573	22.1	yellow white	light yellow	starch
Tamayutaka	Kanto No. 33 × Kanto No. 19	1960	3343	21.0	light pink	yellow white	starch
Konasengan	Kanto No. 33 × Norin No. 1	1962	2862	23.6	light brown	light yellow	starch
Koganesengan	Kakei 7-120 × L-4-5	1965	3490	27.6	light yellow	light yellow	starch

Note. Data were obtained from the yield test under standard Cultivation in Chiba Breeding center, except Kogane sengan and Genji which were obtained from data in Kumamoto Breeding Center.

Irrigated Land Agiculture in Japan

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Histiorical Review.

The history of the irrigated agriculture on the field in Japan is young. The smallest scale irrigated agriculture has been practised by the vegetable producers in the suburb for the last five hundred years but those cases were not many.

Since the Meiji era the European agricultural technique and ideas have been introduced to Japan and affected the field crop management, nevertheless the development in field irrigation lagged behind. The reason is that the paddy rice cultivation is the mainstay in Japan's agriculture and the stress was laid on the use of water for paddy field, moreover, such crops as mulberry, sweetpotatoes, barley and soybeans which are hardly susceptible from water shortage in the soil have been cultivated on the field.

Total yearly precipitation in the main irrigated agricultural areas in the world is less than six hundred millimeters, but in Japan it is from fifteen hundred to thirty hundred millimeters which belongs to humid-wet zone by Klage's geological classification, so it was small wonder that the Japanese took it for granted that the field crops would grow well with natural rainfall without vast expenditure on irrigation projects.

The areas which have total yearly rainfall of over one thousand millimeters are those between the northern and southern twenty degrees latitude; eastern United States, Canadian Pacific coast, England, Norway, East India, Burma, Middle and South China, Japan, Korea, Formosa, Caribbean coast, the Peninsula, Eastern Australia, New Zealand and Middle and South Chili, which occupy about twenty five percent of the land in the world.

The land where the irrigated agriculture is practised among these areas is the eastern United States, and other few countries like Japan or Formosa have primitive irrigated agriculture.

Irrigated agriculture in the eastern United States has developed on vegetable crops and dairy farming, which is practised in smaller scale compared to that of the western United States because the irrigation project is scheduled independently by each farm. But accord-