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Fruit Varieties Journal 48(2):73-80 1994

Conservation System of Fruit Tree Genetic Resources and Recently Released Cultivars from Fruit Tree Research Station in Japan

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Abstract

Plant genetic resources, including fruit, are becoming increasingly significant on a worldwide scale. In Japan also, the importance of genetic diversity of crops has been recognized and the Gene Bank System has been developed for crop breeding. This manuscript gives basic information about conservation of fruit tree genetic resources and new cultivars released recently from the Fruit Tree Research Station in Japan.

Introduction

The Gene Bank Project was started in 1985 by the Ministry of Agriculture, Forestry and Fisheries (MAFF), with the creation of exploration, introduction, classification, conservation, evaluation, utilization and documentation of genetic resources systems. In this project, the National Institute of Agro-

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biological Resources (NIAR) has functioned as a 'Center-Bank' for all crop genetic resources. For fruit tree crops, the Fruit Tree Research Station (FTRS) was designated as a 'Sub-Bank.' Through this project, we have gradually increased introduction of new cultivars and strains bred in the foreign countries, as well as local cultivars and wild types. These materials have been used in breeding after they have been evaluated.

Conservation of Fruit Tree Genetic Resources

In general, fruit trees are conventionally maintained in the field, where it makes possible to observe morphological characteristics of the materials and, later, allows ready access to scions or germplasm in answer to demand.

Fruit tree genetic resources are conserved at Miyazaki of Kyushu National Agricultural Experiment Station and Shinjo of Tohoku National Agricultural Experiment Station, Hokkaido National Agricultural Experiment Station and 7 Stations of the National Center for Seeds and Seedlings (NCSS) in addition to FTRS and the 4 Branches to avoid extinction by unforeseen problems. In Morioka Branch of FTRS, apple, European pear, cherry, blueberry and currant are mainly conserved. Japanese pear, chestnut and drupaceous fruit are conserved in the Main Station located in Tsukuba City. Citrus, jujube, loquat and olive are conserved in Okitsu Branch, and grape, persimmon and kiwi fruit are in Akitsu Branch, and citrus and fig are in Kuchinotsu Branch of FTRS (Fig. 1). Presently, 7,848 fruit tree genetic resources have been conserved in these stations (Table 1), and the introduction of new accessions has averaged about 300 per year. FTRS introduced more than 70 fruit tree species from 37 foreign countries. Many fruit tree accessions were introduced from Nepal, USA, Canada, Taiwan, China, Italy and other countries from 1985 to 1992. Besides introduction from foreign countries, exploration and collection missions by the International Board for Plant Genetic Resources or MAFF have contributed to the increase of fruit tree genetic resources. Apple, drupaceous fruit, citrus, and grape and loquat were introduced following missions to Taiwan, Nepal, Thailand, Italy and CIS from 1985 to 1992.

Table 1. Total number of fruit tree genetic resources conserved in FTRS.[z]

Fruit tree	Total	Working Collection	Base Collection	Active Collection
Apple	1792	360	1432	1134
European pear	170	55	115	105
Cherry	253	133	120	89
Quince	25	11	14	14
Walnut	96	58	38	18
Blueberry	55	29	26	26
Currant	41	13	28	28
Raspberry	40	14	26	26
Asian pear	443	109	334	323
Chestnut	270	54	216	203
Peach	623	186	437	256
Plum	238	113	125	114
Apricot	162	78	84	73
Mume	145	10	135	101
Grape	734	251	483	343
Persimmon	414	61	353	254
Kiwi fruit[y]	45	31	14	10
Pomegranate	45	45	--	--
Jujube	22	18	4	4
Akebia	13	13	--	--
Fig	60	10	50	50
Loquat	71	38	33	27
Citrus	1680	256	1424	574
Wax myrtle	27	11	16	15
Olive	30	--	30	30
Cherimoya[x]	55	55	--	--
Feijoa	13	13	--	--
Guava	13	13	--	--
Others	273	260	13	13
Total	7848	2298	5550	3830

[z]This list represents 1992 figures.
[y]Including *Actinidia* genus.
[x]Including *Annona* genus.

Future Problems

Plant improvement has relied historically on genetic diversity, recom

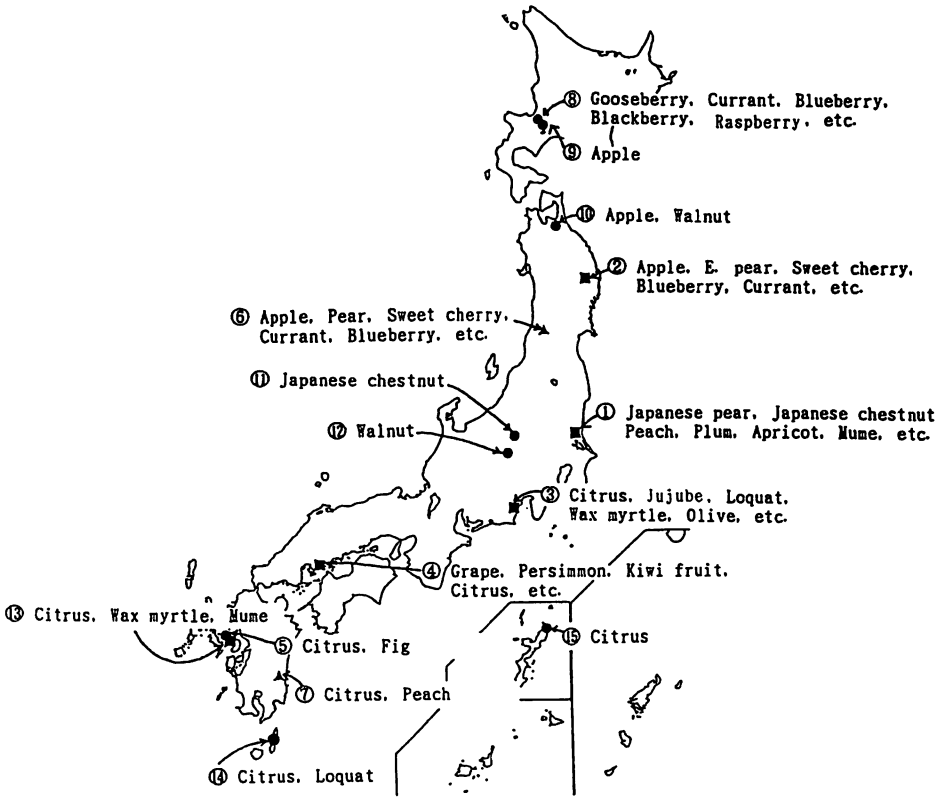

Figure 1. Areas of Japan where fruit tree genetic resources are conserved.
① Fruit Tree Research Station (FTRS), Main Research Station
② FTRS, Morioka Branch
③ FTRS, Okitsu Branch
④ FTRS, Akitsu Branch
⑤ FTRS, Kuchinotsu Branch
⑥ Tohoku National Agricultural Experiment Station, Shinjo
⑦ Kyushu National Agricultural Experiment Station, Miyazaki
⑧ Hokkaido National Agricultural Experiment Station
⑨ National Center for Seeds and Seedlings (NCSS), Hokkaido Central Station
⑩ NCSS, Kamikita Station
⑪ NCSS, Tsumagoi Station
⑫ NCSS, Yatsugatake Station
⑬ NCSS, Unzen Station
⑭ NCSS, Kagoshima Station
⑮ NCSS, Okinawa Station

bination and evaluation. Without genetic diversity segregation is restricted to a narrow genetic base and the opportunity for extensive genetic improvements are limited. Thus, future plant breeding opportunities, especially in the area of insect and disease resistance, will depend heavily on adequately conserved genetic resources that maintain diversity.

At present, field conservation is a common system for fruit tree genetic resources. However, this system is labor intensive, expensive, and subject to losses by various abiotic and biotic agents. Alternative systems using *in vitro* techniques such as cryopreservation in liquid nitrogen or minimum growth storage are described and have been examined (8-14).

In this paper, we described the conservation systems in Japan and omitted discussions on the quarantine system, virus-elimination and the exchange policy for fruit tree genetic resources of FTRS. A flow chart of the total management of introduced fruit tree genetic resources is presented in Fig. 2.

Recently Released Cultivars in FTRS

Twenty-three cultivars were released from FTRS during the past 6 years (1988 to 1993). Historical characteristics of these cultivars are summarized in Table 2. Some other characteristics of fruit and tree are as follows.

Apple

Sansa.—Fruit: 200 to 250g, conical, yellow green ground color with bright red, whitish yellow flesh, Brix 13%, malic acid 0.4 to 0.5%, slightly aromatic flavor, shelf life 2 to 3 weeks and 1 month in cold storage, ripening early Sep. in breeding place. Tree: slightly upright in young stage and gradually spread, slightly weak.

Kizashi.—Fruit: 200g, conical to conical-round, yellow green ground color with red to deep red, white flesh, Brix 13%, malic acid 0.63 to 0.93%, slightly aromatic flavor, shelf life 5 to 6 days and 20 days in cold storage, ripening mid to late Aug. in breeding place. Tree: semi-upright in young stage and gradually spread, vigorous growth on

Table 2. Historical characteristics of recently released cultivars from FTRS.

Cultivar name		Date of register	Parents	Breeding place	Ref.
Apple	Sansa	1988	Gala X Akane	Morioka Branch of TFRS[z]	27
	Kizashi	1991	Gala X Fuji	ibid.	28
Japanese pear	Syuugyoku	1988	Kikusui X Kousui	Main Research Stn. of FTRS[y]	1
	Chikusui	1989	Housui X Hakkou	ibid.	2
	Yasato	1990	Hakkou X 75-23	ibid.	3
Peach	Chiyohime	1988	Kouyouhakuto X Saotome	ibid.	25
	Chiyomaru	1989	21-26 X Numome OP-2	ibid.	20
	Shizukured	1993	open pollinated seedling of 19-1	ibid.	4
	Chiyodared	1993	Hiratsukared X Nectare 5	ibid.	4
	Hitachired	1993	19-18 X Fantasia	ibid.	4
	Yoshihime	1993	21-18 X Akatsuki	ibid.	5
	Masahime	1993	21-18 X Akatsuki	ibid.	6
Persimmon	Shinsyuu	1991	Okitsu 20 X Okitsu 1	Akitsu Branch of FTRS[x]	22
	Youhou	1991	Fuyuu X Jirou	ibid.	24
Grape	Aki Seedless	1988	Muscat Bailey A X Himrod	ibid.	21
	North Red	1992	Seneca X Campbell Early	ibid.	23
Citrus	Kousyun Ponkan	1991	Nucellar seedling of ponkan	Okitsu Branch of FTRS[w]	26
	Hayasaki	1988	Matou Buntan X Hirado Bun;tan	Kuchinotsu Branch of FTRS[v]	15
	Nankou	1989	Miho-wase X Clementine	ibid.	16
	Seihou	1989	Kiyomi tangor X Minneola tangelo	ibid.	17
	Hayaka	1990	Imamura unshiu X Nakano No. 3 ponkan	ibid.	18
	Tsunokaori	1991	Kiyomi tangor X Okitsu wase	ibid.	7
	Benimadoka	1993	Mato buntan X Hirado buntan	ibid.	19

[z]Morioka, Iwate 020-01. Japan.
[y]Tsukuba, Ibaraki 305, Japan.
[x]Akitsu, Hiroshima 729-24, Japan.
[w]Shimizu, Shizuoka 424-02, Japan.
[v]Kuchinotsu, Nagasaki 859-25, Japan.

M. prunifolia but slightly weak on M.26, spur good but few axillary flower buds.

Japanese Pear

Shuugyoku.—Fruit: 400g, oblate, yellowish green at early maturity and yellow at full maturity with somewhat large dots, white flesh, slightly aromatic flavor, Brix 12.7%, pH 5.0, shelf life 7 to 10 days at 25 °C, ripening early to mid Sep. in breeding place. Tree: moderately vigorous, resistant to black spot disease (*Alternaria alternata* Japanese pear pathotype) and pear necrotic spot virus.

Chikusui.—Fruit: 250g, oblate, yellowish brown, white flesh, slightly aromatic flavor, Brix 11.7%, pH 5.12, shelf life 5 to 7 days at 25 °C, ripening early to mid Aug. in breeding place. Tree: moderately vigorous, resistant to black spot disease and pear necrotic spot virus.

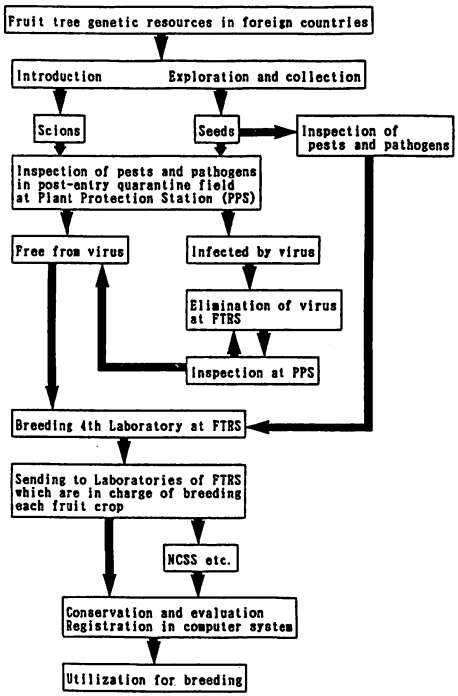

Figure 2. Flow chart of the total management of introduced fruit tree genetic resources.

Yasato—Fruit: 250g, round oblong, yellowish green at early maturity and yellow at full maturity, white flesh, slightly aromatic flavor, Brix 12.0%, pH 4.81, shelf life 7 days at 25 °C, ripening mid Aug. in breeding place. Tree: vigorous, resistant to black spot disease and pear necrotic spot virus.

Peach

Chiyohime.—Fruit: 120 to 180g, round elliptic, white flesh with some red pigment, soft melting, Brix 10%, pH 4.2 to 4.6, clingstone and some split-pits, ripening early July in breeding place. Tree: open, moderately vigorous and productive.

Chiyomaru—Fruit:120 to 180g, round shape, yellow flesh without red pigment, soft melting, Brix 10%, pH 4.5 to 4.9, clingstone and little pit splitting, ripening early July in breeding place. Tree: spreading, vigorous and productive.

Shizukured.—Fruit: 140g, round elliptic and uniform, yellow flesh and slightly red near the pit, soft melting, Brix 10.3%, pH 3.6, clingstone and a little split-pit, ripening early July in breeding place. Tree: moderately vigorous and moderately productive.

Chiyodared.—Fruit: 170g, round to round elliptic and uniform, yellow flesh and slightly red near the pit, soft melting, Brix 11.4%, pH 3.5, clingstone and a little split-pit, ripening mid July. Tree: moderately vigorous and moderately productive.

Hitachired.—Fruit: 180g, round to round elliptic and uniform, yellow flesh and slightly red near the pit, soft melting, Brix 10.6%, pH 3.5, clingstone and a little split-pit, ripening mid July in breeding place. Tree: vigorous and moderately productive.

Yoshihime.—Fruit: 235g, round, white flesh with red pigment, Brix 12.4%, pH 4.4, clingstone, ripening late July to early Aug. in breeding place. Tree: vigorous, spreading and productive.

Masahime.—Fruit: 220g, round to round elliptic, white flesh with red pigment,

Brix 13.0%, pH 4.4, clingstone, ripening late July to early Aug. in breeding place. Tree: vigorous, spreading and fairly productive.

Persimmon

Shinsyuu.—Fruit: 240g, roundish oblate and no grooves, yellow to orange, light orange flesh with few brown specks, soluble solids 17 to 18%, pollination constant non-astringent, ripening mid to late Oct. in breeding place. Tree: productive and moderately vigorous, female flowers only.

Youhou.—Fruit: 240g, oblate and no grooves, red to orange, deep orange flesh with brown specks of medium density in the flesh, soluble solids 15 to 17%, pollination constant non-astringent, ripening early Nov. in breeding place. Tree: productive and moderately vigorous, female flowers only.

Grape

Aki Seedless.—Fruit: 500 to 700g, winged conical and well-filled, berries 3 to 3.5g short elliptic, seedless, purple black, Brix 18 to 19%, free acid 0.5%, no aroma, ripening late Aug. in breeding place. Tree: fairly vigorous, productive and moderately resistant to ripe rot and downy mildew.

North Red.—Fruit: 250 to 300g, compact and winged-cylindrical, berries 4g round, red to brown or violet to red, Brix 17 to 19%, free acid 0.4 to 0.6%, foxy aroma, ripening late Aug. in breeding place. Tree: moderately vigorous, productive and fairly resistant to diseases and insects.

Citrus

Kousyun Ponkan.—Fruit: 130g, oblate, rind color light orange to orange, easy to peel, orange to light orange flesh, soluble solids 13%, 5 to 15 polyembryonic seeds, ripening late Dec. to mid Jan. Tree: vigorous, upright, resistant to citrus scab, resistant to citrus canker and citrus tristeza virus.

Hayasaki.—Fruit: 600 to 1,000g, oblate to pyriform, rind color light yellow, difficult to peel, greenish yellow flesh, soluble solids 12 to 15%, 50 to 100 monoembryonic seeds, self incompatible, ripening late Dec. to early Jan. in breeding place. Tree: vigorous, upright in young stage and spreading later, moderately resistant to citrus scab, susceptible to citrus canker.

Nankou.—Fruit: 130g, oblate to subglobose, rind color deep to reddish orange, peeled although moderately adherent, deep orange flesh, soluble solids 12 to 15%, seedless, ripening mid to late Dec. in breeding place. Tree: medium vigorous, upright in young stage and spreading later, susceptible to citrus scab and resistant to citrus canker.

Seihou.—Fruit: 200g, subglobose, rind color orange to deep orange, difficult to peel, orange flesh, soluble solids 11 to 14%, seedless, ripening mid to late Jan. in breeding place. Tree: medium vigorous, spreading, resistant to citrus scab and susceptible to citrus canker, subject to preharvest fruit dropping.

Hayaka.—Fruit: 150g, oblate, rind color orange to yellowish orange, easy to peel, orange flesh, soluble solids 13 to 16%, seeds few and polyembryonic, ripening early to mid Dec. in breeding place. Tree: moderately vigorous, upright to spreading, resistant to citrus scab and moderately resistant to citrus canker.

Tsunokaori.—Fruit: 160g, oblate, rind color orange to yellowish orange, peeled although moderately adherent, orange flesh, soluble solids 13 to 16%, seedless, ripening late March to mid April. Tree: medium vigorous, spreading, resistant to citrus scab and moderately resistant to citrus canker.

Benimadoka.—Fruit: 700 to 1,000g, oblate to broadly globose, rind color pale yellow, yellowish white to yellow with pale reddish pigment, soluble solids 13 to 15%, ripening mid Jan. to Feb. in breeding place. Tree: vigorous, upright in young stage, resistant to citrus seab but somewhat susceptible to citrus canker.

Furthermore 13 cultivars (1 Japanese pear, 1 peach, 1 Japanese chestnut, 2 persimmons, 4 table grapes and 4 citrus) are in the process of registration. Two apple cultivars, 'Sansa' and 'Kizashi,' were bred by cooperation with Department of Scientific and Industrial Research of New Zealand. Such examples of international cooperation in breeding as well as in exchange of genetic resources, should be developed further in the future. These 23 cultivars are available for research purposes after distribution and testing agreements have been completed. Breeding 4th laboratory at FTRS is responsible to the distribution and offer the informations of these cultivars.

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