〔AREIPGR Vol. 39: 37-55, 2023〕
doi:10.24514/0002000125

Original Paper

Collection and Conservation of Crop Landraces Including the Families Brassicaceae, Cucurbitaceae, Fabaceae, and Poaceae in the Region Around Aso and Kuju Mountains and Itsuki Village of Kumamoto Prefecture

Hirotaka ARIGA[1)], Yu TERASHIMA[2)], Shin-ichi YAMAMOTO[1)], Yu TAKAHASHI[1)]

1) Research Center of Genetic Resources, National Agriculture and Food Research Organization (NARO), 2-1-2 Kannondai, Tsukuba, Ibaraki 305-8602, Japan
2) *Local study group of Itsuki Village*

Communicated by N. TOMOOKA (Research Center of Genetic Resources)
Received: July 31, 2023; Accepted: September 26, 2023
Corresponding author: Y. TAKAHASHI (e-mail: takahashi0126@affrc.go.jp)

Summary

This paper reports the collection and conservation of plant genetic resources in 2022, mainly including crop landraces in the region around the Aso and Kuju mountains and Itsuki Village of Kumamoto Prefecture. Crop landrace seeds were provided by farmers after their fields were surveyed, while seeds of *Brassica* plants growing naturally in artificially disturbed environments were additionally collected, as some landraces are expected to have escaped. We collected and conserved a total of 26 accessions, comprising 2 accessions of mustard (*Brassica juncea* (L.) Czern.), 1 of tatsoi (*Brassica rapa* L. emend. Metzg. subsp. *narinosa* (Bailey) Hanelt), 6 of oilseed rape (*Brassica rapa* L. emend. Metzg. subsp. *oleifera* (DC.) Metzg.), 4 of turnip (*Brassica rapa* L. emend. Metzg. subsp. *rapa*), 2 of radish (*Raphanus sativus* L.), 6 of cucumber (*Cucumis sativus* L.), 1 of soybean (*Glycine max* (L.) Merr.), 2 of azuki bean (*Vigna angularis* (Willd.) Ohwi et Ohashi), 1 of rice bean (*Vigna umbellata* (Thunb.) Ohwi et Ohashi) and 1 of maize (*Zea mays* L.). These are registered at the National Agriculture and Food Research Organization (NARO) Genebank. Notably, this report includes the first introduction of the tatsoi landrace "Kurona," a rare subspecies from Japan, into the NARO Genebank. Moreover, we prevented the loss of the azuki bean landrace "Keshogo" and waxy maize landrace "Mochi-Tokibi." The NARO Genebank will preserve these seeds after multiplication and distribute them for research and educational purposes (https://www.gene.affrc.go.jp/index_en.php).

KEY WORDS: Brassicaceae, Conservation, Crop landraces, Cucurbitaceae, Fabaceae, Genebank, Poaceae, Plant genetic resources

Introduction

The National Agriculture and Food Research Organization (NARO) Genebank is expressing renewed interest in the conservation of crop landraces (Ariga and Takahashi 2022). This initiative was prompted by two main factors. The first refers to a provision from the Plant Variety Protection and Seed Act that came into effect as of April 1, 2021 in Japan (House of Councillors, The National Diet of Japan [in Japanese]; https://www.sangiin.go.jp/japanese/gianjoho/ketsugi/203/

f070_120102.pdf), which calls for "promoting the conservation of crop landraces by public research institutions" (excerpts and translations by the authors) in its supplementary resolution. The second factor refers to an aim from "Goal 2: Zero Hunger"—"maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species"—of the Sustainable Development Goals (https://sdgs.un.org/goals). This aim suggests that conserving crop landraces is a challenge faced by both Japan and the rest of the world.

Kyushu Island is the third-largest and most southerly out of the four main islands in Japan. "Kyushu Island" is a geoscientific term referring to a single island, while "Kyushu region" is a geopolitical term referring to Kyushu Island, its surrounding islands, and Okinawa Prefecture. Kyushu Island includes seven prefectures: Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, and Kagoshima. Fukuoka, its most northerly prefecture, had a population of over 5 million people as of January 1, 2023, rendering it the most urbanized prefecture of Kyushu region (Fukuoka Prefectural Government [in Japanese]; https://www.pref.fukuoka.lg.jp/contents/fukuokakennojinkoutosetai.html). Although Kyushu Island is classified as "Humid subtropical climate (Cfa)" according to the Köppen climate classification, the region around the Kuju mountains in Oita Prefecture (highest altitude: 1,791 m) and Aso mountain in Kumamoto Prefecture (highest altitude: 1,592 m) have a cooler climate (Kumamoto Local Meteorological Office [in Japanese]; https://www.jma-net.go.jp/kumamoto/shosai/climate.html).

Similar to other regions in Japan, the agricultural households of Kyushu region are facing aging and deterioration, making the conservation of crop landraces an urgent priority. According to the FY2021 results, Kyushu region represents the food supply source for Japan, accounting for 20% of the national share of gross agricultural production (Kyushu Regional Agricultural Administration Office [in Japanese]; https://www.maff.go.jp/kyusyu/kikaku/attach/pdf/mirusiru_2023-23.pdf). Looking at the gross agricultural production over the past 50 years, the value peaked in 1990, after which it showed a declining trend and later increased for 7 consecutive years after 2011. Subsequently, the values showed a declining trend since 2018, but began to increase once more in 2021. Although the average age of farmers in Kyushu region is 1.4 years younger than the national average, it is still over 66 years old, evidencing the aging of the farming population. Simultaneously, the number of agricultural households is 165,000, which is approximately 30% lower than it was 10 years ago.

Under the Japanese government, the NARO Genebank has been conducting *ex-situ* conservation of plant genetic resources and third-party distribution for research and educational purposes. Although the NARO Genebank has conserved 359 landraces from Kumamoto Prefecture as of 2023, the majority of these are cereal and legume landraces, with the number of vegetable genetic resources being far from sufficient. To the best of the authors' knowledge, there are certain vegetable landraces in Kumamoto Prefecture that are not conserved in the NARO Genebank. After a detailed evaluation of the vegetable landraces in the region around the Aso and Kuju mountains and in Itsuki Village in Kumamoto Prefecture, we planned to conduct a field survey in late May, when the weather begins to warm up in spring, just before the rainy season. Since this survey was simultaneously conducted along a survey of crop wild relatives described in a separate report in this journal, two accessions from Fukuoka and Oita Prefectures have been included.

Methods

The field survey was conducted in Kumamoto Prefecture between May 25 and 30, 2022 (Table 1, Fig. 1). Information on some crop landraces was provided by Mr. Tetsuya Kino, from the Itsuki Village Board of Education. We visited farmers who cultivated crop landraces in their fields, interviewed them regarding the conservation status of their crops, recorded their "passport data," and received seeds from farmers who agreed to the NARO Genebank policy. "Passport data" refers to specific information of the collected materials, such as name, collection method, and collection site. We also recorded the "passport data" of plants growing naturally and collected seeds from their corresponding habitats after obtaining permission from landowners, as some landraces are expected to have escaped and appear growing naturally. We used Google Maps and Google Earth to determine the latitude, longitude, and altitude of each cultivation site and habitat, which were included in the "passport data." Mature seeds of target crops with immature seeds at the time of the survey were mailed to us after harvest by a local cooperator. We assigned the collected plants to each taxon based on APG system IV (The Angiosperm Phylogeny Group *et al*. 2016) and the International Code of Nomenclature for algae, fungi, and plants. For some *Brassica* spp., we also listed the cultivar group names used in the NARO Genebank, which is based on the International Code of Nomenclature of Cultivated Plants. For the romanization of Japanese

Table 1. Itinerary of the field survey

Date	Itinerary
25-May-22	Haneda Airport – ANA643 – Kumamoto Airport[1] – Itoshima City[2] – Otsu Town[1] (Stay)
26-May-22	Otsu Town[1] – Minamiaso Village[1] – Otsu Town[1] (Stay)
27-May-22	Otsu Town[1] – Taketa City[3] – Otsu Town[1] (Stay)
28-May-22	Otsu Town[1] – Oguni Town[1] – Otsu Town[1] (Stay)
29-May-22	Otsu Town[1] – Itsuki Village[1] – Otsu Town[1] (Stay)
30-May-22	Otsu Town[1] – Kumamoto Airport[1] – ANA2418 – Haneda Airport

[1]Kumamoto Prefecture

[2]Fukuoka Prefecture

[3]Oita Prefecture

botanical names, we adopted the Hepburn system following the NARO Genebank method, ignoring long vowels, enclosing them in double quotation marks, and capitalizing the initials of all words by using hyphens as word separators.

Results and Discussion

We collected and conserved a total of 26 accessions consisting of 2 accessions of mustard (*Brassica juncea* (L.) Czern.), 1 accession of tatsoi (*Brassica rapa* L. emend. Metzg. subsp. narinosa (Bailey) Hanelt), 6 accessions of oilseed rape (*Brassica rapa* L. emend. Metzg. subsp. *oleifera* (DC.) Metzg.), 4 accessions of turnip (*Brassica rapa* L. emend. Metzg. subsp. *rapa*), 2 accession of radish (*Raphanus sativus* L), 6 accessions of cucumber (*Cucumis sativus* L.), 1 accession of soybean (*Glycine max* (L.) Merr.), 2 accessions of azuki bean (*Vigna angularis* (Willd.) Ohwi et Ohashi), 1 accession of rice bean (*Vigna umbellata* (Thunb.) Ohwi et Ohashi) and 1 accession of maize (*Zea mays* L.) (Table 2, Fig. 2). The "passport data" for each accession is shown in Table 3, while the characteristics of each taxon are described below.

Brassicaceae

Mustard (*Brassica juncea* (L.) Czern.)

Two accessions—FK03 and FK06—were identified as mustard (*B. juncea*). FK03 was found growing naturally along the roadside in a hilly area within the fields of Minamiaso Village, Kumamoto Prefecture (Fig. 3). We identified FK03 as a mustard because of its pungent seeds and sessile leaves at the flowering stem (unlike the clasping leaves of *B. rapa*) (Fig. 4). According to Professor Emeritus Takayuki Tanaka of Tokai University, who was present for the collection of FK03, the paddy field across the road is one for practical training at Tokai University, where a leaf mustard landrace "Aso-Takana" is planted every year after the rice harvest. Mustard growing in Japan is divided into two taxa: Indian mustard (*Brassica juncea* (L.) Czern. subsp. *juncea*) and leaf mustard (*Brassica juncea* (L.) Czern. subsp. *integrifolia* (West) Thell.). As the plant had withered away, we were unable to identify the taxon below the species for FK03; nevertheless, we considered it an "Aso-Takana" escapee.

The other accession, FK06, is a leaf mustard landrace "Kuju-Takana," found cultivated in a field owned by Mr. Atsushi Kamiyoshi, chairman of the non-profit organization "Kuju kogen michikusa annainin kurabu" (Figs. 5 and 6). Because this species is autogamous, we received the seeds derived from one out of twenty plants that had been cultivated. Mr. Atsushi Kamiyoshi informed us that "Aso-Takana" and "Kuju-Takana" were differentiated from the same ancestor after the Edo period (1603–1868), with "Kuju-Takana" possessing a more pungent taste and more deeply lobed leaf than those of "Aso-Takana." While the leaves of most Japanese leaf mustard are used for pickles from the vegetative growth stage, the flowering stem and leaf of "Aso-Takana" and "Kuju-Takana" are mainly used for pickles. "Kuju-Takana" seems to be more similar to *B. juncea* subsp. *juncea* because it lacks the broad petioles and curly leaves characteristic of "Miike-Takana," a famous leaf mustard landrace in Fukuoka Prefecture; however, *B. juncea* used as a vegetable in Japan is generally classified as *B. juncea* subsp. *integrifolia*. We plan to evaluate the characteristics and chloroplast genotypes of FK03 and FK06 along with JP26124, an existing "Aso-Takana" accession in the NARO Genebank.

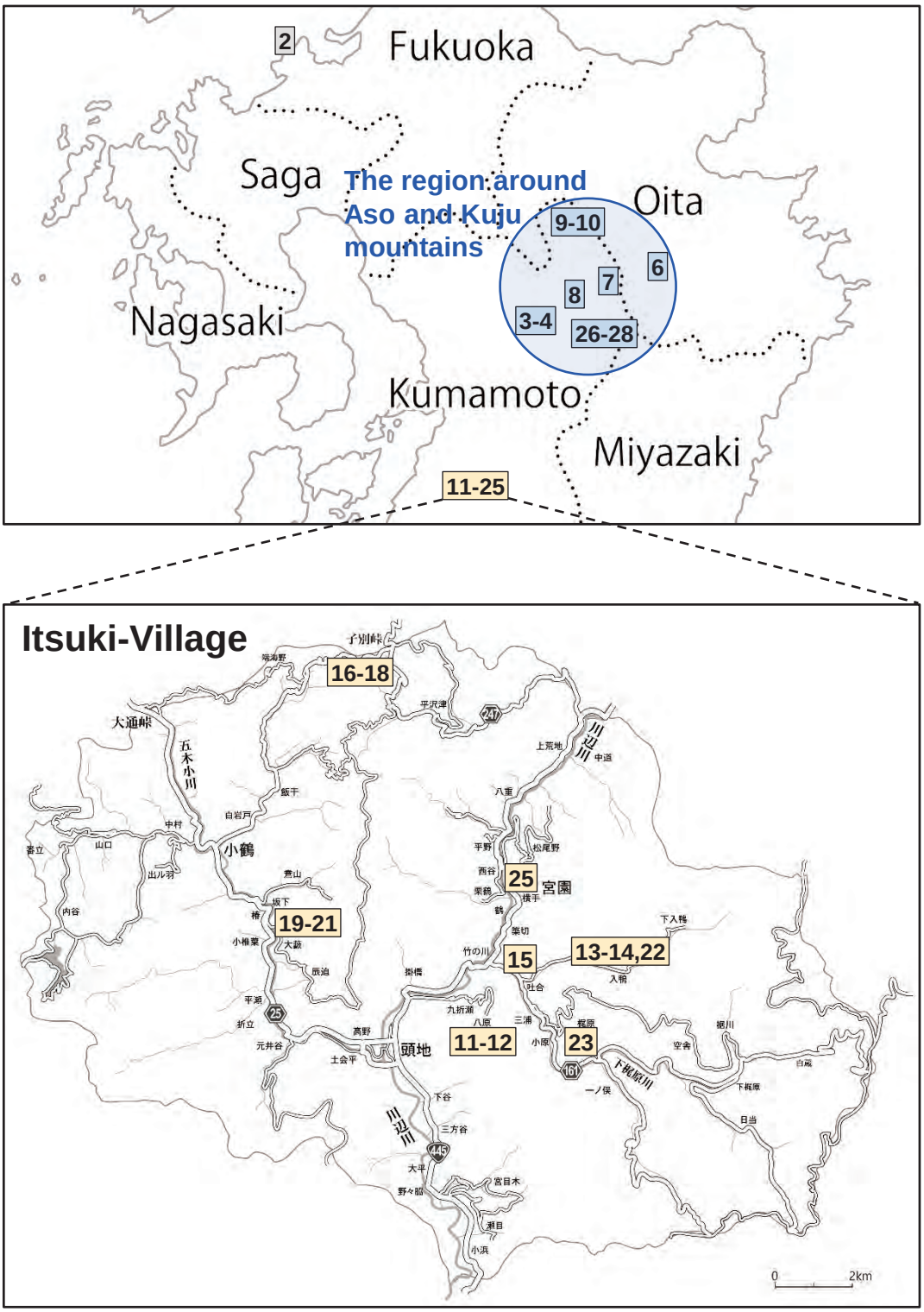


Fig. 1. Collection sites corresponding to the ID nmbers in Table 3.

Tatsoi (*Brassica rapa* L. emend. Metzg. subsp. *narinosa* (Bailey) Hanelt)

=*Brassica rapa* L. Narinosa Group (in the NARO Genebank)

One accession—FK09—was identified as tatsoi (*B. rapa* subsp. *narinosa*). FK09 is a landrace called "Kurona," cultivated in Oguni Town, Kumamoto Prefecture; it was obtained from five plants that had been harvested and dried as whole plants for seed collection. We identified FK09 as *B. rapa* subsp. *narinosa* based on its dark green color and numerous rosette leaves (Fig. 7). Because Oguni town is a hot-spring area, FK09 grew in a field where the soil temperature was so high that steam was generated (Fig. 8). In winter, "Kurona" is cultivated in a unique environment where the plant is covered by snow, but the soil temperature is high. "Kurona" used to

Table 2. Summary of the collections

Family	Scientific name	Number of collections
Brassicaceae	*Brassica juncea* (L.) Czern.	2
	Brassica rapa L. emend. Metzg. subsp. *narinosa* (Bailey) Hanelt	1
	Brassica rapa L. emend. Metzg. subsp. *oleifera* (DC.) Metzg.	6
	Brassica rapa L. emend. Metzg. subsp. *rapa*	4
	Raphanus sativus L.	2
Cucurbitaceae	*Cucumis sativus* L.	6
Fabaceae	*Glycine max* (L.) Merr.	1
	Vigna angularis (Willd.) Ohwi et Ohashi	2
	Vigna umbellata (Thunb.) Ohwi et Ohashi	1
Poaceae	*Zea mays* L.	1
	Total	26

be a valuable winter vegetable in this region, but only five farms have continued cultivating it. Considering that most *B. rapa* plants are allogamous owing to self-incompatibility and only five plants were available in a field for seed collection, FK09 may be facing genetic erosion.

Oilseed rape (*Brassica rapa* L. emend. Metzg. subsp. *oleifera* (DC.) Metzg.)
=*Brassica rapa* L. Oleifera Group (in the NARO Genebank)

Six accessions were identified as oilseed rape (*B. rapa* subsp. *oleifera*): FK07, FK08, FK14, FK15, FK21, and FK22. FK07 and FK08 were collected in the region around the Aso and Kuju mountains, Kumamoto Prefecture (Fig. 1). FK07 was found growing naturally on the roadside, with red coloration on the lower part of its stem (Figs. 9 and 10). According to the landowner, the plant had been cultivated for lamp fuel more than 20 years ago. Another accession—FK08—was observed growing naturally all over a terraced field (Fig. 11). The landowner, who was born in 1944, informed us that when he was in elementary school, his father used to press oil from the seeds of this plant for cooking (Fig. 12). Based on these findings, FK07 and FK08 were considered to be escapees from the oilseed rape landraces cultivated in this region of Kumamoto Prefecture. We identified FK07 and FK08 as *B. rapa* subsp. *oleifera* based on their clasping leaf at the flowering stem, buds buried in open flowers at the inflorescence, and usage (Fig. 10).

Four accessions—FK14, FK15, FK21, and FK22—were edible plants called "Kona" that grew naturally in Itsuki Village or were cultivated in fields by some farmers. Populations with light green leaves are commonly called "Fuyu-Gona" or "Haru-Gona" by locals, whereas populations with dark green leaves are referred to as "Kuro-Gona," but no clear classification rules exist. The word "Gona" is an inflectional form ("rendaku" in Japanese) that occurs when the word "Kona" is connected to another word. "Fuyu" means winter, "Haru" means spring, and "Kuro" means black. The populations varied in the degree of leaf color, lobes, and hairs. FK14 and FK15 are called "Fuyu-Gona" for their light green leaves, as can be seen in Fig. 13. Plants were left to dry in fields for seed collection (Fig. 14), while many escapees like FK15 were growing naturally in Itsuki Village (Fig. 15). FK22 is called "Haru-Gona," and the seeds collected in May 2022 were provided by a farmer. Another accession, FK21, is a seed of "Kuro-Gona" harvested in the field over 20 years ago by a farmer in Itsuki Village. We expect that there may be relatively little genetic contamination from hybridization with commercial cultivars, as the seeds were collected at an older date. Elucidating the characteristics of all these accessions, including FK21, is a future challenge. We classified these plants as *B. rapa* subsp. *oleifera* based on the absence of characteristics identified in other taxa in *B. rapa*. These include a thick taproot-like turnip (*B. rapa* subsp. *rapa*), numerous rosette leaves like those of tatsoi (*B. rapa* subsp. *narinosa*), large leaf head like that of Chinese cabbage (*Brassica rapa* L. emend. Metzg. subsp. *pekinensis* (Lour.) Hanelt), thick petiole like that of bok choy (*Brassica rapa* L. emend. Metzg. subsp. *chinensis* (L.) Hanelt), and large inflorescence like that of broccoletto (*Brassica rapa* L. emend. Metzg. subsp. *oleifera* (DC.) Metzg var. *ruvo* (Bailey) Hammer).

Turnip (*Brassica rapa* L. emend. Metzg. subsp. *rapa*) = *Brassica rapa* L. Rapifera Group (in the NARO Genebank)

Four accessions were identified as turnips (*B. rapa* subsp. *rapa*) growing naturally in Kumamoto Prefecture: FK04, FK11, FK12, and FK13. These often grew naturally in fallow fields or roadsides, but their origin is unknown (Figs. 16–22). Although naturally growing turnips, such as FK11–13, have been long reported in Itsuki Village, no such records exist for Minamiaso Village, where FK04 was collected (Fig. 16). The morphology of the taproots belonging to FK04, FK11, FK12, and FK13 suggests that they are not escapees from any commercial cultivars (Figs. 17, 20, 21). Locals informed us that FK13 had begun growing naturally on a newly created slope after a landslide occurred in 2021 and that the upslope had been previously slash-and-burn farmed (Fig. 22). Some Japanese turnip landraces have long been cultivated under slash-and-burn agriculture, as represented by "Atsumi-Kabu" in Yamagata Prefecture (Yamagata-Zairai-Sakumotsu-Kenkyuukai 2007). Thus, we speculated that FK13 could be an escape and survivor of turnip landrace cultivated on slash-and-burn farming. Globally, turnips are phylogenetically differentiated into two groups, those from Asia and Europe; the Japanese landraces are mostly monophyletic from Asia (Takahashi *et al*. 2016). FK04, FK11, FK12, and FK13 could potentially have a genetic background specific to the European type because of their many leaf hairs and lateral roots, lack of seed coat mucilage, and late maturity. Considering that the resistance gene for clubroot was isolated from the European type, these accessions could represent valuable genetic resources (Yoshikawa 1993; Hirai 2006). In a future study, we intend to conduct phylogenetic analyses and evaluate their characteristics.

Radish (*Raphanus sativus* L.)

One accession each of radish landrace (FK16) and wild radish (FK02) were collected. FK16 is a radish landrace that is currently cultivated by only three farmers in Itsuki Village (Fig. 23). In addition to the roots, the flowering stems, flowers, and pods also showed red coloration (Figs. 23–26). Locals used to eat its lightly dried leaves as preserved food. As radish is an allogamous plant owing to self-incompatibility and only three plants were left in a field for seed collection, FK16 may be facing genetic erosion. Considering that no specific name was given to this radish landrace, we decided to bestow FK16, a valuable genetic resource, the Japanese accession name "Itsuki-Aka-Daikon," meaning the red radish from Itsuki Village.

The wild radish accession FK02 (*Raphanus sativus* L. var. *raphanistroides* Makino) was found growing on a beach in Itoshima City, Fukuoka Prefecture (Figs. 27 and 28). We had previously surveyed six populations of this taxon in Hyogo Prefecture and found no notable characteristics between them and FK02 (Ariga and Takahashi 2022). This survey was simultaneously conducted along a survey of crop wild relatives in a separate report. Although this taxon appears to be a crop wild relative rather than an escapee, FK02 has been included in this report because a domesticated radish of the same species was described above (FK16).

Cucurbitaceae

Cucumber (*Cucumis sativus* L.)

Six accessions of cucumber landrace were collected: FK18, FK19, FK20, FK26, FK27, and FK28. FK18, FK19, and FK20 were cultivated in Itsuki Village (Figs. 1, 29, 30). Locals refer to the landrace with green or white fruit as "Ji-Kyuri" and that with red or orange fruit as "Aka-Kyuri." These are still cultivated throughout Itsuki Village, with their color varying among districts.

Three accessions—FK26, FK27, and FK28—were sold as seedlings at the "Namino" road station, in the region around the Aso and Kuju mountains (Fig. 1), as "Ji-Kyuri," with each product labeled with the name of the producer. We collected these seedlings and successfully multiplied the seeds by cultivating them in a greenhouse for the NARO Genebank at Tsukuba City, Ibaraki Prefecture. These showed different fruit colors and sizes, suggesting genetic differences (Figs. 31–33).

Fabaceae

Soybean (*Glycine max* (L.) Merr.)

A single accession of soybean landrace (FK10), expressed as a small and flattened black-seeded soybean, was collected. FK10 is called "Oguni-Kuro-Daizu" and is cultivated in Oguni Town, the region around the Aso and Kuju mountains, in Kumamoto Prefecture (Fig. 1). The bean sprout made from "Oguni-Kuro-Daizu" has been valued as a winter vegetable similar to the tatsoi landrace "Kurona" (FK09) in Oguni Town. The beans for sprout are soaked in spring water at around 28 ºC throughout the year, which is available at a shrine called "Nakao Atsuta Jingu," and grown under paddy straw to avoid light. The bean sprouts can be harvested after one week, having grown to approximately 20 cm in length. In the past, each family cultivated their own "Oguni-Kuro-Daizu," but only one producer for "Oguni-Kuro-Daizu" remained by 2010. Because "Oguni-Kuro-

Daizu" was registered as an "Aso's Agricultural Heritage Resource" in 2016, the Oguni town social welfare council began promoting its conservation in 2019. "Oguni-Kuro-Daizu" are used as an ingredient for miso and sprouts but are also served as rice cooked with beans or sweet boiled beans in a restaurant run by the council (Fig. 34). Its cultivation is unique because it is sown in late June to early July, its upper stem is pinched in late August to early September, and it is harvested in late November owing to its indeterminate growth habit. The main purpose of pinching the upper stem seems to be facilitating its management and consequently increasing its yield.

Azuki bean (*Vigna angularis* (Willd.) Ohwi et Ohashi)

Two accessions of azuki bean landrace were collected: FK17 and FK25. These were cultivated in Itsuki Village (Fig. 1). FK17 is characterized by having red seeds larger than those of common Japanese azuki bean (Fig. 2), and a farmer was storing numerous seeds in their shed (Fig. 35). The other accession, FK25, had mottled red and white seed coats and was called "Keshogo" (Fig. 2). Currently, a single farmer stores "Keshogo"; according to them, this landrace shows a higher yield than that of common azuki bean and its bean softens quickly when boiled. However, the farmer also stated they might quit cultivating this landrace next year. Therefore, this survey helped prevent the loss of "Keshogo."

Rice bean (*Vigna umbellata* (Thunb.) Ohwi et Ohashi)

One accession of rice bean landrace, FK23, was collected; it was cultivated in Itsuki Village and is called "Nanba" (Fig. 2). "Nanba" is edible in the form of sweet bean paste, similar to the azuki bean. Rice and azuki beans were the crops cultivated using slash-and-burn farming in Itsuki Village. Experiments using rice and azuki bean landraces collected from slash-and-burn farming areas in Shiiba Village, Miyazaki Prefecture, showed that rice bean has a higher ability to uptake phosphoric acid than that of azuki bean in phosphate-deficient soil (Kondo and Koga 2021).

Poaceae

Maize (*Zea mays* L.)

One accession of waxy maize landrace (FK17.5) called "Mochi-Tokibi" was collected, found hanging on a shed in Itsuki Village (Figs. 1, 36, 37). The famer who owned the shed told us that "the kernels pop and become sticky after a short time when boiled" and "we have not cultivated this maize for a long time." FK17.5 is its last survivor and needs early seed multiplication as some time has passed since the last seed harvest.

Future prospects

Notable highlights of this report include the first introduction of the "Kurona" tatsoi landrace, a rare subspecies in Japan, into the NARO Genebank and the prevention of the loss of the azuki bean landrace "Keshogo" and waxy maize "Mochi-Tokibi." An issue observed in this survey was that some allogamous crops had seeds collected from a few plants without sufficient measures to prevent cross-contamination. Smaller populations make it more difficult to overcome incompatibility and are thus more susceptible to genetic contamination from cross pollination with neighboring cultivars or escapees. Hence, farmers who conserve allogamous crop landraces on-farm should be instructed to perform seed multiplication using a sufficient number of plants isolated from other populations of the same species. In the NARO Genebank, seed multiplication of allogamous Brassicaceae species is performed in individual fine-netted greenhouses using approximately 50 plants per cultivar and random crossing by insect (Figs. 38 and 39). The NARO Genebank preserves these seeds after multiplication to distribute them for research and educational purposes (https://www.gene.affrc.go.jp/index_en.php).

Author contributions

HA and YTa planned the study with input from YTe and SY. HA, YTe, SY, and YTa surveyed the field and took photos. HA and YTa wrote the manuscript with input from YTe and SY.

Acknowledgments

We are grateful to Ms. Harumi Mominoki, Mr. Hideyuki Sakata, Dr. Takayuki Tanaka, and Mr. Tetsuya Kino for assisting in this survey, as well as to Dr. Norihiko Tomooka and Ms. Kyoko Motoyoshi for cultivating cucumber seedlings (FK26, FK27, and FK28) and providing seeds. This work was supported by the Genebank Project of the National Agriculture.

References

Ariga H and Takahashi Y (2022) Conservation of crop landraces and crop wild relatives in Hyogo Prefecture in 2021. AREIPGR 38: 43-57.
[Genebank, NARO], [JaLC]

Hirai M (2006) Genetic analysis of clubroot resistance in *Brassica* crops. Breed Sci 56 (3): 223-229.
[JaLC]

Kondo T and Koga K (2021) Growth traits of adzuki bean and rice bean grown in phosphate deficient soil. Research for Tropical Agriculture 14 (1): 1-7 (in Japanese with English Abstract).
[JaLC]

Takahashi Y, Yokoi S and Takahata Y (2016) Genetic divergence of turnip (*Brassica rapa* L. em. Metzg. subsp. *rapa*) inferred from simple sequence repeats in chloroplast and nuclear genomes and morphology. Genet Resour Crop Evol 63 (5): 869-879.
[CrossRef]

The Angiosperm Phylogeny Group (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Bot J Linn Soc 181 (1):1-20.
[CrossRef]

Yamagata-Zairai-Sakumotsu-Kenkyuukai (2007) Dokokano Hatake no Katasumi de -Zairai Sakumotsu ha Yamagata no Bunkazai- (in Japanese). Yamagata University Press, pp. 122-123.
[ISBN 978-4-903966-02-1]

Yoshikawa H (1993) Studies on breeding of clubroot resistance in cole crops. Bull Natl Res Inst Veg, Ornam Plants & Tea Japan, Ser A 7: 1-165 (in Japanese with English summary).
[AgriKnowledge]

熊本県阿蘇・九重山周辺地域および五木村における アブラナ科，ウリ科，マメ科，イネ科作物 在来品種の収集と保全

有賀 裕剛[1)]・寺嶋 悠[2)]・山本 伸一[1)]・高橋 有[1)]

1) 国立研究開発法人 農業・食品産業技術総合研究機構（農研機構）遺伝資源研究センター
2) 五木郷土研究会

和文摘要

本報告は，福岡県，熊本県，大分県における在来作物の保全に関する報告書である．我々は，農業環境と自然環境を調査し，生産者等から在来作物の種子を譲り受けると共に，自生植物から種子を収集した．その結果，カラシナ 2 点，クロナ 1 点，在来ナタネまたはツケナ類 6 点，カブ 4 点，ダイコン 2 点，キュウリ 6 点，ダイズ 1 点，アズキ 2 点，ツルアズキ 1 点，トウモロコシ 1 点の計 26 点の遺伝資源を収集した．本報告の新規性は，アズキ在来品種「ケショウゴ」とトウモロコシ在来品種「モチトウキビ」の消失を阻止したほか，日本では希少なタアサイの在来品種「クロナ」を農研機構のジーンバンクに導入したことである．これらの種子は増殖後，研究または教育を目的とする利用のために配布される予定である（https://www.gene.affrc.go.jp/index_en.php）．

Table 3. Passport data of the collections

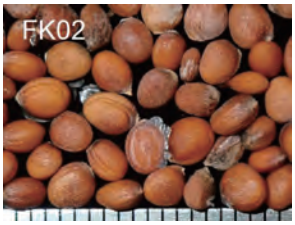
ID, Accession number	Scientific name, “Local name”	Status, Sampling method, Source, Collection date	Collection site	Latitude, Longitude, Altitude (m)	Topography, Soil type, Remark
FK02, JP278952	*Raphanus sativus* var. *raphanistroides*, “Hamadaikon”	Growing naturally (wild), Population, Habitat, 2022/5/25	Itoshima City, Fukuoka Pref.	33.6003388720502, 130.153880637885, 5	Plain, Sand, Seeds collected from 20 plants
FK03, JP278953	*Brassica juncea*, -	Growing naturally (weedy), Population, Habitat, 2022/5/26	Minamiaso Village, Kumamoto Pref.	32.8879681142176, 130.99562896725, 439	Mountains, Organic soil
FK04, JP278954	*Brassica rapa* ssp. *rapa*, -	Growing naturally (weedy), Population, Habitat, 2022/5/26	Minamiaso Village, Kumamoto Pref.	32.9012828286987, 130.995759655578, 470	Mountains, Organic soil, Pungent seeds
FK06, JP278955	*Brassica juncea*, “Kuju-Takana”	Cultivated (landrace), Individual, Farmer's field, 2022/5/27	Taketa City, Oita Pref.	33.031689182711, 131.307070807889, 558	Mountains, Organic soil, Seeds collected from one plant
FK07, JP278956	*Brassica rapa* ssp. *oleifera*, -	Growing naturally (weedy), Population, Habitat, 2022/5/27	Ubuyama Village, Kumamoto Pref.	33.0027631178574, 131.237181009535, 575	Mountains, Volcanic ash soil, Red coloring on the stem, Cultivated for fuel of lamps more than 20 years ago
FK08, JP278957	*Brassica rapa* ssp. *oleifera*, -	Growing naturally (weedy), Population, Habitat, 2022/5/27	Aso City, Kumamoto Pref.	32.9735848851708, 131.139013349939, 568	Mountains, Organic soil, Used for edible oil more than 70 years ago
FK09, JP278958	*Brassica rapa* ssp. *narinosa*, “Kurona”	Cultivated (landrace), Population, Farmer's field, 2022/5/28	Oguni Town, Kumamoto Pref.	33.1556170557984, 131.13664654705, 700	Mountains, Organic soil, Seeds collected from five plants
FK10, JP278959	*Glycine max*, “Oguni-Kuro-Daizu”	Cultivated (landrace), Population, Farmer's stock, 2022/5/28	Oguni Town, Kumamoto Pref.	33.1561905434974, 131.12200345398, 624	Unknown, Unknown, Sold at the restaurant “Tenku no mamebatake”
FK11, JP278960	*Brassica rapa* ssp. *rapa*, “Yama-Kabu”	Growing naturally (weedy), Population, Farmer's field, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4055278828262, 130.850516676691, 658	Mountains, Organic soil
FK12, JP278961	*Brassica rapa* ssp. *rapa*, “Yama-Kabu”	Growing naturally (weedy), Population, Farmer's field, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4056927508222, 130.850415690471, 657	Mountains, Organic soil

Table 3. (Continued).

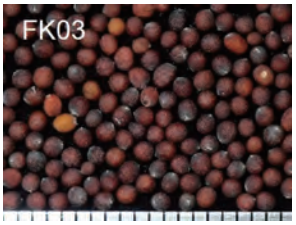
ID, Accession number	Scientific name, “Local name”	Status, Sampling method, Source, Collection date	Collection site	Latitude, Longitude, Altitude (m)	Topography, Soil type, Remark
FK13, JP278962	*Brassica rapa* ssp. *rapa*, “Yama-Kabu”	Growing naturally (weedy), Population, Habitat, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.417440606795, 130.885015815517, 556	Mountains, Gravel, Area with limestone, Above the cliff was the slash-and-burn field
FK14, JP278963	*Brassica rapa* ssp. *oleifera*, “Kona”	Growing naturally (weedy), Population, Farmer's field, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4172295823817, 130.885560913377, 551	Mountains, Organic soil
FK15, JP278964	*Brassica rapa* ssp. *oleifera*, “Kona”	Growing naturally (weedy), Population, Habitat, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4172109729151, 130.855382861611, 313	Mountains, Organic soil
FK16, JP278965	*Raphanus sativus*, “Itsuki-Aka-Daikon” (The native wa gave it)	Cultivated (landrace), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4901816930855, 130.823606633401, 965	Mountains, Organic soil, Seeds collected from four plants
FK17, JP278966	*Vigna angularis*, “Azuki	Cultivated (landarace), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4901816930855, 130.823606633401, 965	Mountains, Organic soil, Large seeds
FK17.5, JP278967	*Zea mays*, “Mochi-Toukibi”	Cultivated (landrace), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4901816930855, 130.823606633401, 965	Mountains, Organic soil, The farmer said the crop would not be cultivated in the future
FK18, JP278968	*Cucumis sativus*, “Ji-Kyuri”	Cultivated (landrace), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4903373587403, 130.824357752347, 967	Mountains, Organic soil
FK19, JP278969	*Cucumis sativus*, “Ji-Kyuri”	Cultivated (landrace), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4314271737745, 130.791454070814, 385	Mountains, Organic soil
FK20, JP278970	*Cucumis sativus*, “Aka-Kyuri”	Cultivated (langrace), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4314271737745, 130.791454070814, 385	Mountains, Organic soil
FK21, JP278971	*Brassica rapa* ssp. *oleifera*, “Kona”	Growing naturally (weedy), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4314271737745, 130.791454070814, 385	Mountains, Organic soil, Moldy seeds 20 years old

Table 3. (Continued).

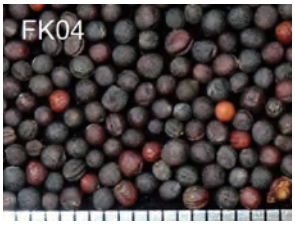
ID, Accession number	Scientific name, “Local name”	Status, Sampling method, Source, Collection date	Collection site	Latitude, Longitude, Altitude (m)	Topography, Soil type, Remark
FK22, JP278972	*Brassica rapa* ssp. *oleifera*, “Kona”	Growing naturally (weedy), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.417519882507, 130.882365561139, 538	Unknown, Unknown
FK23, JP278973	*Vigna umbellata*, “Nanba”	Cultivated (landrace), Population, Farmer's stock, 2022/5/29	Itsuki Village, Kumamoto Pref.	32.4062981861658, 130.874344572577, 665	Unknown, Unknown
FK25, JP278974	*Vigna angularis*, “Keshougo”	Cultivated (landrace), Population, Farmer's stock, 2022/6/15	Itsuki Village, Kumamoto Pref.	32.4343470297175, 130.860655538937, 328	Unknown, Unknown, Seeds received by mail
FK26, JP278975	*Cucumis sativus*, “Ji-Kyuri”	Cultivated (landrace), Individual, Market, 2022/5/27	Aso City, Kumamoto Pref.	32.9598583195654, 131.19748297785, 725	Unknown, Unknown, Seedling sold at the roadside station “Namino”
FK27, JP278976	*Cucumis sativus*, “Ji-Kyuri”	Cultivated (landrace), Individual, Market, 2022/5/27	Aso City, Kumamoto Pref.	32.9598583195654, 131.19748297785, 725	Unknown, Unknown, Seedling sold at the roadside station “Namino”
FK28, JP278977	*Cucumis sativus*, “Ji-Kyuri”	Cultivated (landrace), Individual, Market, 2022/5/27	Aso City, Kumamoto Pref.	32.9598583195654, 131.19748297785, 725	Unknown, Unknown, Seedling sold at the roadside station “Namino”



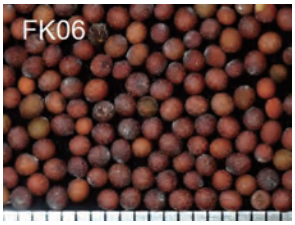
JP278952 (FK02),
Raphanus sativus var.
anistroides



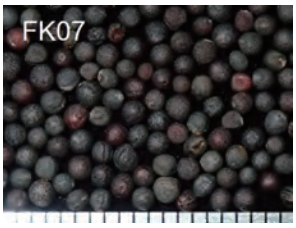
JP278953 (FK03),
Brassica juncea



JP278954 (FK04),
Brassica rapa ssp. *rapa*

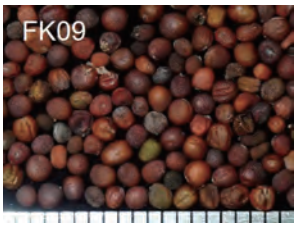


JP278955 (FK06),
Brassica juncea



JP278956 (FK07),
Brassica rapa ssp. *oleifera*

JP278957 (FK08),
Brassica rapa ssp. *oleifera*



JP278958 (FK09),
Brassica rapa ssp. *narinosa*

JP278959 (FK10),
Glycine max

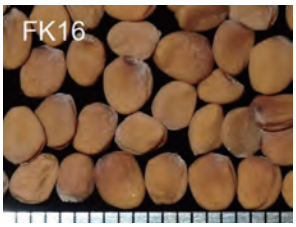
JP278960 (FK11),
Brassica rapa ssp. *rapa*

JP278961 (FK12),
Brassica rapa ssp. *rapa*

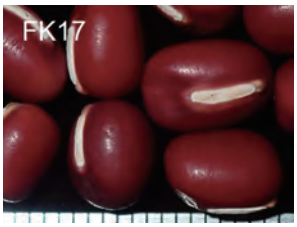
JP278962 (FK13),
Brassica rapa ssp. *rapa*

JP278963 (FK14),
Brassica rapa ssp. *oleifera*

JP278964 (FK15),
Brassica rapa ssp. *oleifera*



JP278965 (FK16),
Raphanus sativus

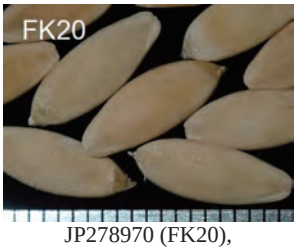


JP278966 (FK17),
Vigna angularis

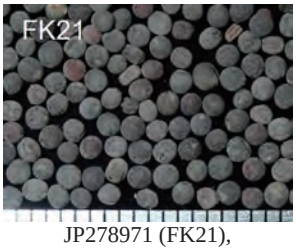
JP278967 (FK17.5),
Zea mays

JP278968 (FK18),
Cucumis sativus

JP278969 (FK19),
Cucumis sativus

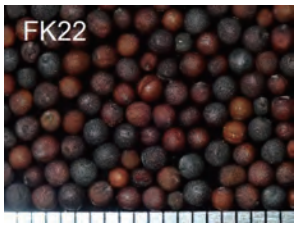


JP278970 (FK20),
Cucumis sativus



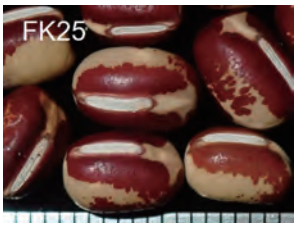
JP278971 (FK21),
Brassica rapa ssp. *oleifera*

Fig. 2. Images of collected seeds. Seeds of FK26, FK27, and FK28 were obtained from seedlings collected in Kumamoto Prefecture and cultivated in the NARO Genebank.



JP278972 (FK22),
Brassica rapa ssp. *oleifera*

JP278974 (FK23),
Vigna umbellata



JP278974 (FK25),
Vigna angularis

JP278975 (FK26),
Cucumis sativus

JP278976 (FK27),
Cucumis sativus

JP278977 (FK28),
Cucumis sativus

Fig. 2. (Continued).

Fig. 3. Habitat of naturally growing mustard (FK03).

Fig. 4. Sessile leaf at the flowering stem of naturally growing mustard (FK03).

Fig. 5. Cultivated mustard landrace "Kuju-Takana" (FK06).

Fig. 6. Lobed leaf of mustard landrace "Kuju-Takana" (FK 06).

Fig. 7. Photograph of tatsoi landrace "Kurona" plants displayed in the "Tenku no mamebatake" restaurant (FK09).

Fig. 8. Field with rising steam for tatsoi landrace "Kurona" (FK09).

Fig. 9. Habitat of oilseed rape (FK07).

Fig. 10. Clasping leaf at the flowering stem of oilseed rape (FK07).

Fig. 11. Habitat of oilseed rape (FK08).

Fig. 12. Interviews conducted with the landowner regarding FK08.

Fig. 13. Cultivated plants with light green leaves of leaf vegetable landrace “Kona” (FK14).

Fig. 14. Dried plants of leaf vegetable landrace “Kona” (FK14).

Fig. 15. Habitat of naturally growing leaf vegetable “Kona” (FK15).

Fig. 16. Habitat of naturally growing turnip (FK04).

Fig. 17. Root of nayurally growing turnip (FK04).

Fig. 18. Naturally growing turnip plants (FK12).

Fig. 19. Inflorescence of naturally growing turnip (FK12).

Fig. 20. Root of naturally growing turnip (FK12).

Fig. 21. Root of naturally growing turnip (FK13).

Fig. 22. Riverbank where landslide occurred (FK13).

Fig. 23. Harvested red radish landrace "Itsuki-Aka-Daikon" (FK16).

Fig. 24. Growing red radish landrace "Itsuki-Aka-Daikon" (FK16).

Fig. 25. Inflorescence of red radish landrace "Itsuki-Aka-Daikon" (FK16).

Fig. 26. Pods of red radish landrace "Itsuki-Aka-Daikon" (FK16).

Fig. 27. Habitat of wild radish (FK02).

Fig. 28. Collected pods of wild radish (FK02).

Fig. 29. Cultivated plants of cucumber landrace "Ji-Kyuri" (FK18).

Fig. 30. Young fruit with flower of cucumber landrace "Ji-Kyuri" (FK18).

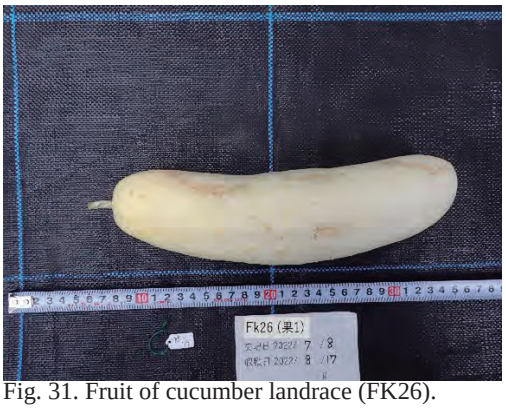


Fig. 31. Fruit of cucumber landrace (FK26).

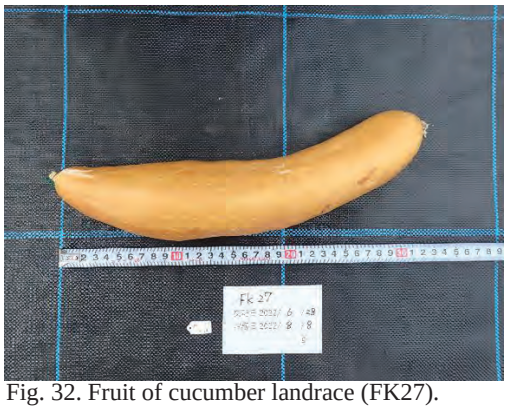


Fig. 32. Fruit of cucumber landrace (FK27).

Fig. 33. Fruit of cucumber landrace (FK28).

Fig. 34. Rice with black soybean landrace "Oguni-Kuro-Daizu" (FK10).

Fig. 35. Azuki beans stored in a shed (FK17).

Fig. 36. Shed-hanging waxy maize landrace “Mochi-Toukibi” (FK17.5)

Fig. 37. Kernels of waxy maize landrace “Mochi-Toukibi” (FK17.5).

Fig. 38. Field with fine netting for seed multiplication of allogamous plants in the NARO Genebank.

Fig. 39. Flies for random crossing of allogamous Brassicaceae plants used in the NARO Genebank.