

Conservation and Management of Plant Genetic Resources in Nagano Prefecture, Japan

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Summary : The current status of *ex situ/in situ* conservation of plant genetic resources for food and agriculture (PGRFA) and issues related to their management was surveyed in Nagano Prefecture. Genetic resources from numerous PGRFA landraces and local varieties have been collected by the Gene bank Project to date. However, most of these varieties have disappeared, particularly those of major cereals and grain legumes, due to changes in agriculture and rural/modern lifestyles. Formalization of the seed-production system from a local system to a larger-scale seed system, combined with initiatives like the 'Shinshu traditional vegetable' certification system would facilitate the conservation of PGRFA at the farm level.

Introduction

Since ratifying the Convention on Biological Diversity (CBD) at the Earth Summit in Rio de Janeiro in 1993, Japan has been required to increase its conservation efforts, encourage the sustainable use of its biodiversity, and promote the equitable utilization of benefits derived from the utilization of biological resources. In Japan, an initiative to conserve genetic resources related to food and agriculture was officially launched by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in 1985. Specifically, the focus of the Gene bank Project is the conservation of genetic resources from plants, microorganisms and animals, particularly plant genetic resources for food and agriculture (PGRFA), which are threatened by genetic erosion and environmental degradation. The National Institute of Agrobiological Sciences (NIAS) is responsible for coordinating the project and several comprehensive studies of PGRFA using so called 'ex situ conservation' methods have been conducted to date¹⁻⁹⁾. As a result, numerous PGRFA have been collected at national and international levels^{10,11)}.

Conversely, conservation by cultivation on farms, also referred to as '*in situ* conservation',

can only be effective if there is a continuous demand for landraces and local varieties. However, *in situ* conservation has become increasingly difficult as the balance between human activities and the environment has been disrupted¹²⁾.

Nagano Prefecture is located in the center of the Japanese mainland (Honshu Island). The prefecture is surrounded by the Northern, Southern and Central Japan Alps with average altitudes of 3000 m. The inland location and high altitude of the prefecture means that the climate and agro-ecological diversity range from temperate to subarctic zones and, consequently, that a wide variety of crops can be cultivated in the prefecture. This variety of habitats also means that Nagano Prefecture has a relatively diverse PGRFA, although these resources are gradually being eroded through the development of improved F₁ varieties.

This report describes the current status of PGRFA in Nagano Prefecture within the context of both *in situ* and *ex situ* conservation measures. In addition, the results of field and literature surveys are presented and the issues surrounding on-farm conservation and future management of PGRFA resources in Nagano Prefecture are discussed.

Table 1 Collection surveys conducted by NIAS Genebank in Nagano Prefecture.

Year	Main target crops, genus and species	Remark
2006	Genus <i>Malus</i>	
2004	wild relatives of fruit trees	
2001	Genus <i>Vigna</i> , <i>Vicia</i> and <i>Glycine</i> <i>Sesamum indicum</i> and <i>Perilla frutescens</i>	
1999	<i>Prunus tomentosa</i> (downy cherry)	
1997	<i>Trifolium pratense</i> (red clover) <i>Fagopyrum esculentum</i> (buckweat)	
1995	<i>Medicago polymorpha</i> (toothed medich)	
1994	<i>Fagopyrum esculentum</i> (buckweat)	
1991	local legumes and millets	at Shimoina Dist.
1989	local legumes and millets <i>Astragalus sinicus</i> (Chinese milk vetch)	at Hokushin Area
	Genus <i>Dyanthus</i>	
1988	local legumes and millets local legumes and millets <i>Sesamum indicum</i> and <i>Perilla frutescens</i>	at Shimoina Dist. at Tohshin Area
1987	<i>Lolium perenne</i> (perennial ryegrass)	
1986	grasses (<i>Phleum pratense</i> etc.)	

This table was compiled based on the the Annual Report on Exploration and Introduction of Plant Genetic Resources*

Collection PGRFA resources in Nagano Prefecture

According to the Annual Report on Exploration and Introduction of Plant Genetic Resources published by NIAS Genebank¹⁾, a total of 173 collection-based PGRFA surveys were conducted in Japan from 1986 to 2009. In Nagano Prefecture, 18 surveys were undertaken in collaboration with researchers from the Nagano Agricultural Experiment Station and extension workers (Table 1)¹⁻⁹⁾. Since relatively extensive collections of most of the major cereals (e.g. rice and wheat) have already been conducted, more recent surveys have focused on the intensive collection of millets and grain legumes. For example, a high diversity of millets and legumes has been reported at Akiyama - Go in the village of Sakae in Kamiminochi District and at Toyama - Go in the Shimoina District. In addition to these crops, other species, such as grasses, sesame, perilla and fruit trees, and their wild relatives have also been investigated.

As of 2008, the total number of plant resources collected and maintained by the NIAS Genebank exceeded 240,000¹³⁾. Information related to the

registered genetic resources is stored in a database that can be accessed by the public over the internet¹⁴⁾. For Nagano Prefecture, a search for the type of resource (e.g. landrace, wild, and weeds) delivered a total of 39 species and 673 accessions (Table 2). These results showed that wide variety of species have been collected in Nagano Prefecture, particularly of soybeans, adzuki beans, rice, common millet and foxtail millet.

The Nagano Agriculture Research Center has also been conducting their own PGRFA surveys and relatively many accessions have been stored at each facility (Table 3)¹⁵⁾. Of these accessions, numerous breeding lines, introduced lines or varieties, and derived lines, as well as landraces and local varieties, have been collected. Main crop species preserved are different from the centers. The Nagano Foundation Seed Center (NFSC) is responsible for backing up important plant genetic resources at a prefectural level.

Current situation of PGRFA on farm level

1-1. Cereals, grain legumes and millets

Breeding focusing on the cultivation of major cereals, grain legumes and fodder crops, such as

Table 2 Species and number of accessions in Nagano Prefecture obtained by searching the NIAS Genebank database.

Scientific name	Common name	Common name in Japanese	Number of accessions
<i>Oryza sativa</i>	rice	イネ	67
<i>Hordeum vulgare</i>	barley	オオムギ	1
<i>Triticum aestivum</i>	wheat	コムギ	2
<i>Zea mays</i>	maize	トウモロコシ	6
<i>Sorghum bicolor</i>	sorghum	ソルガム	14
<i>Panicum miliaceum</i>	common millet	キビ	35
<i>Setaria italica</i>	foxtail millet	アワ	34
<i>Eleusine coracana</i> ssp. <i>coracana</i>	finger millet	シコクビエ	3
<i>Echinochloa utilis</i>	barnyard millet	ヒエ	5
<i>Lespedeza striata</i>	Japanese lespedeza	ヤハズソウ	1
<i>Lespedeza stipulacea</i>	none	マルバヤハズソウ	2
<i>Lespedeza cuneata</i>	sericea lespedeza	メドハギ	1
<i>Phleum pratense</i>	timothy	オオアワガエリ	13
<i>Dactylis glomerata</i>	orchard grass	カモガヤ	11
<i>Astragalus sinicus</i>	astragal	ゲンゲ	2
<i>Vicia sativa</i>	common vetch	オオカラスノエンドウ	1
<i>Zoysia japonica</i>	Korean lawn grass	ノシバ	10
<i>Glycine max</i>	soybean	ダイズ	289
<i>Vigna angularis</i>	adzuki bean	アズキ	82
<i>Vigna angularis</i> var. <i>nipponensis</i>	none	ヤブツルアズキ	15
<i>Glycine soja</i>	wild soybean	ツルマメ	19
<i>Paseolus vulgaris</i>	common bean	インゲンマメ類	7
<i>Fagopyrum esculentum</i>	buckwheat	ソバ	12
<i>Sesamum indicum</i>	sesami	ゴマ	18
<i>Perilla frutescens</i>	perilla	エゴマ	18
<i>Juncus decipiens</i>	soft rush	イグサ	4
<i>Raphanus sativus</i>	Japanese radish	ダイコン	6
<i>Brassica rapa</i> Rapifera group	turnip	カブ・ツケナ類	1
<i>Solanum melongena</i> var. <i>esculentum</i>	eggplant	ナス	1
<i>Prunus persica</i>	peach	モモ	3
<i>Pyrus</i> sp.	pear	ヤマナシ	2
<i>Castanea crenata</i>	Japanese chestnut	ニホングリ	2
<i>Dispyros kaki</i>	persimmon	カキ	5
<i>Prunus armeniaca</i>	apricot	アンズ	8
<i>Malus prunifolia</i>	siebold crabapple	マルバカイドウ	5
<i>Malus sieboldii</i>	toringo crabapple	ズミ	9
<i>Morus alba</i>	white mulberry	マグワ	9
<i>Morus latifolia</i>	large-leaved mulberry	クチグワ	5
<i>Morus bimbycis</i>	chinesemulberry	ヤマグワ	12
Total 39 species			673

Table 3 Collections of plant genetic resources held by the Nagano Agricultural Research Center.

Name of the storage facility	Main crop species	Number of accessions
Nagano Agricultural Experiment Station	Rice, etc.	4,185
Breeding Department, Nagano Agricultural Experiment Station	Wheat, etc.	5,216
Nagano Chushin Agricultural Experiment Station	Corn, etc.	5,026
Nagano Fruit Tree Experiment Station	Apple, etc.	322
Designated Test Area for Sorghum, Nagano Livestock Experiment Station	Sorghum, etc.	3,500
Nagano Foundation Seed Center	Rice, etc.	3,785

rice, wheat, barley, maize, soybean, sorghum, is primarily undertaken by the various national and prefectural Agricultural Research Centers. The centers produce and release improved varieties of these crops, which are better adapted to the sometimes marked differences in the local climate and agricultural areas of Japan. Indeed, over the last few decades, almost all of the known landrace and local varieties have been displaced by improved varieties and many are no longer cultivated at the farm-level. For example, there are 14 recommended varieties of rice in Nagano Prefecture and these varieties are used in almost all areas under to rice cultivation in the prefecture¹⁶⁾. Similarly, the five released varieties of wheat cover 98.6% of the area under wheat cultivation¹⁷⁾, and four varieties of soybean cover 94.1% of the area under soybean cultivation¹⁸⁾. Local maize has also been replaced by F₁ varieties.

Except in areas dedicated to commercial production, many millets and legumes are only cultivated on very small scales in hilly or mountainous areas. Since some farmers still grow millet, these millet populations are not considered to be relict. However, Kawase et al.⁶⁾ proposed that in the event that these farmers stopped growing millet and then resumed millet cultivation some time later, they are likely to use a newly established millet variety instead of the previous landrace variety.

1-2. The case of Oshika Village in Shimoina District

Using Oshika Village in Shimoina District as an example, this section briefly explores how difficult it is to manage plant genetic resources on a farm level. In 1989 and 1991, field surveys of millets and

grain legumes were conducted by the Genebank Project^{5,6)} (see Table 2). A total of 23 samples were collected, including soybean (*Glycine max*, n = 10), Adzuki bean (*Vigna*, n = 6), common millet (*Panicum miliaceum*, n = 3), foxtail millet (*Setaria italica*, n = 3) and perilla (*Perilla frutescens*, n = 1). After 20 years, in May 2011, the author had the opportunity to interview elderly women from the village who were engaged in farming about landraces and local varieties. They spoke enthusiastically about the cultivation of local varieties and were nostalgic about the past when numerous landraces available. However, at present, almost of the samples collected in the surveys are not widely cultivated and circumstances in the village have changed over the last twenty years as it is mentioned later. For example, one of the landraces that was cultivated twenty years ago in Oshika Village was a local soybean variety called 'Nakao-wase'. However, this variety has now disappeared in the village and it has been replaced with a new variety.

2-1. Vegetables

The current situation regarding local vegetable varieties is somewhat different from that of the cereals and grain legumes described above. Improved varieties, mainly of the F₁, are generally bred by private seed companies and then sold to farmers and cooperatives. Many local vegetable varieties were lost between the late 1960s and 1980s and were then replaced with improved vegetable varieties of cereals and grain legumes.

As shown in Table 1, Nagano Prefecture has relatively few local vegetable varieties. However, compared to the situation in cereals and grain legumes, a relatively high proportion of these

vegetable varieties are still cultivated at the farm level. In Nagano Prefecture, these local vegetable varieties belong to families such as Solanaceae, Cucurbitaceae, Fabaceae, Rosaceae, Asteraceae, Brassicaceae^{19,20}. Ohi et al.¹⁹ reported that vegetables belonging to the Brassicaceae have many local varieties, particularly varieties of the Japanese radish (*Raphanus sativus* var. *longipinnatus*) which are grown in the north and east of the prefecture (Hokushin and Thoshin), and varieties of turnip and tsukena (*Brassica rapa*) grown in the central and southern parts of the prefecture (Chushin and Nanshin). Cultivation area, number of growers, varieties, and number of farmers all influenced the number of seeds that were produced by local farmers using landraces. In particular, the activities of many farmers have been severely impacted by a decrease in successors.

2-2. The case of a local turnip variety 'Seinaiji akane'

The current situation regarding the seed production of local vegetable varieties by farmers is described below. The local turnip variety 'Seinaiji akane' has been cultivated by the Seinaiji community in Achi Village in the Shimoina District since the Edo period (Photo 1). The reddish-purple roots are elongated like a Japanese radish, which accounts for why the variety is referred to as 'Akane Daikon'. Farmers who cultivate 'Seinaiji-Akane' use it to make pickles using traditional methods which they typically eat from March to August (Photo 2).

Approximately 30 houses that produced their own seeds were surveyed. The age of seed producers ranged from 57 to 89 years-old (average: 75 years-old). Seeds were generally produced on a small scale and more than 80% of the seed producers used fewer than 20 mother plants. Half of them were produced by around five mother plants (Photo 3). Difficulties associated with succession on farms and the age of farmers and seed producers are major obstacles to the continued survival of 'Seinaiji Akane' and other local vegetable varieties.



Photo 1 Local turnip variety 'Seinaiji Akane' from Achi Village in the Shimoina District.



Photo 2 Pickled 'Seinaiji Akane' made using traditional methods.



Photo 3 Mother plants used for seed production of 'Seinaiji Akane'.

2-3. 'Shinshu traditional vegetable' certification system

In order to conserve local vegetable varieties in Nagano Prefecture and to encourage succession



Photo 4 Label used for the 'Shinshu traditional vegetables' certification system.

on farms, the 'Shinshu traditional vegetables' certification system was launched by the municipalities of Nagano Prefecture in 2007²¹⁾. The system recognizes a total of 59 varieties of 16 crops: 'Tsukena' (7 varieties), leek (2), eggplant (3), cucumber (8), pumpkin (1), gourds (3), strawberry (1), common bean (1), potato (5), Japanese radish (11), turnip (8), burdock (2), taro (2), wasabi (1), chili peppers (3) and maize (1). The certification system is intended to encourage the cultivation of these local varieties and to promote on-farm conservation. In addition, these certified varieties have become more marketable and are now sought after by the market (Photo 4). However, varieties grown for self-consumption have become increasingly rare.

Conclusions

To date, the preservation of landraces and local varieties has typically been performed by seed-producing farmers. Farmers aged 70 and above are generally considered to be the last generation actively involved in the production of their own seeds. The younger generation has little or no experience of seed production and is frequently not engaged in agricultural activities due to

changes in the rural lifestyle. It has thus become increasingly difficult to conserve landraces and local varieties on farms and to pass on this knowledge to the next generation. Consequently, further collection of PGRFA by 'gleaning' is both necessary and urgent, even though most landraces and local varieties have already been collected. These collection initiatives have played an important role, not only in the preservation of genetic resources for cultivation purposes, but also in recognizing the value of local resources and the importance of participation by farmers and local inhabitants. Nishikawa²²⁾ proposed that genetic resource management has to be inclusive and that it should involve collaboration between researchers, farmers, NGOs and NPOs. If implemented, such initiatives are expected to enhance on-farm conservation.

Conservation by cultivation on farms can only be effective if there is a sustained demand for landraces and local varieties. While farmers have preserved many of these indigenous forms and varieties, their efforts to cultivate and, in so doing, conserve native crops have generally not been supported by/received the support of public institutions. Indeed, although the cultivation of some of these crops is time-intensive, several exemplary farmers have taken the initiative to conserve these varieties irrespective of their market value.

Recent efforts by local government are to revitalize rural areas through promoting local crops as regional specialties. As a result, consumer interest in indigenous vegetables is increasing and their market value is starting to rise.

It may also be necessary to review the methods by which seeds of local vegetable varieties are produced. The local seed system, which refers to seeds that are produced by the farmers themselves, is at risk of disappearing. Indeed, while a paradigm shift will be required to shift local seed production into the mainstream, this could be achieved with the help of a local seed company using local vegetable varieties.

The current status of *ex situ* / *in situ* conservation and management of PGRFA resources in

Nagano Prefecture can be applied to other regions in Japan. Reviews of the situation in the Netherlands²³⁾, Germany²⁴⁾ and UK²⁵⁾ have shown that local varieties are longer cultivated in areas where they were once endemic. Rather, the seeds of plants from these areas are all currently produced by small-scale seed companies who specialize in what is now referred to as 'traditional' or 'old' varieties by hobby farmers. Compared to the European situation, there are still numerous local varieties in Japan. It is therefore necessary to seek alternative ways to create new local varieties as genetic resources and to simultaneously slow down the rate at which PGRFA resources are disappearing.

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長野県における作物遺伝資源の保全とその課題

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要 約

本報告では、長野県における作物遺伝資源の保全状況とその課題について議論した。長野県では、これまでに多くの在来系統や地方品種がジーンバンクプロジェクトによって調査収集されてきた。しかしながら、それらの多く、特に主要穀類やマメ類では、農業を取り巻く環境や生活様式の変化が原因で失われてしまっている。種子生産システムの転換や「信州伝統野菜」認定制度が、今後の農家レベルでの作物遺伝資源の保全を後押しすると考えられる。

キーワード：作物遺伝資源，地方品種，長野県，保全