

## Plant Genetic Resources Collaboration Between Bhutan and the NIAS Genebank, Japan

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**Abstract:** The National Institute of Agrobiological Sciences (NIAS) Genebank coordinates the conservation of plants, microorganisms, animals and DNA materials related to agriculture in Japan. In addition, the NIAS Genebank actively participates in collaborative activities with other countries such as Bhutan. Based on the Memorandum of Understanding (MOU) between the NIAS and the National Biodiversity Center (NBC), Bhutan, a field survey was conducted in Bhutan in 2007 and a Bhutanese scientist Ms. Asta Tamang visited Japan and collected germplasm in Japan. A total of 29 samples of 11 different cereal species and 67 samples of 12 wild and cultivated leguminous species were collected in Bhutan. Plant herbarium specimens were made for most of the wild plants collected and were deposited in the Herbarium of the NBC. All the seed materials collected were deposited in the Genebank of the NBC. The effective survey, preservation, and use of the valuable genetic resources in Bhutan are most urgent themes, and close collaboration in the future between Bhutan and Japan is expected.

**Key word:** Bhutan, field survey, NIAS Genebank, plant genetic resources

### Introduction

Currently genetic resources are being lost at an unprecedented rate due to global environmental disruption and spread of improved crop cultivars. It is an urgent task to conserve the genetic variation of native crops and their related wild species.

In order to facilitate collaborative research activities on the plant genetic resources (PGR), the National Institute of Agrobiological Sciences (NIAS), Japan and the National Biodiversity Center (NBC), Ministry of Agriculture, Bhutan agreed to establish a Memorandum of Understanding (MOU) on Joint Research of Genetic Resources between Bhutan and Japan in 2007. We carried out the collaborative field survey in Bhutan under this MOU.

### Activities of NIAS Genebank

The NIAS operates the Genebank Project as the central coordinating institute for plant, animal and microorganism genetic resources for food and agriculture in cooperation with 15 different research institutes (sub-banks) throughout in Japan. In the plant section, the NIAS Genebank plays the role of headquarters and is preserving seed materials in a large seed storage facility and for vegetatively propagated crops cryo-preservation is used. The sub-banks, which are mostly breeding laboratories in different regions in Japan, are specialized in particular PGRs there. The NIAS Genebank system conserves about 240,000 accessions of PGRs including 45,000 clonally propagating ones. It conserves 132,000 seed samples of about 1,450 plant species as an active collection for distribution. There are two seed storage facilities in the NIAS at Tsukuba, Ibaraki prefecture. One is mid-term storage facility kept at -1°C and 30% relative humidity (RH) for active

collection. The other is long-term storage facility, controlled at  $-10^{\circ}\text{C}$  and 30%RH for about 200,000 accessions of base-collection.

About 3,000 newly registered accessions and 4,000 re-generated accessions are checked for viability every year. In addition, about 20,000 stored accessions are monitored for seed viability. When seed viability decreases below 80% in the case of rice cultivars, for example, seeds are re-generated. The NIAS Genebank is now re-generating about 4,000 accessions annually in cooperation with the sub-banks. The NIAS Genebank distributes PGRs of active collection domestically and internationally for research and educational purposes. The NIAS Genebank distributes about 10,000 accessions annually.

The NIAS Genebank supported the JICA's ODA projects for establishing Genebanks in Sri Lanka, Chile, Pakistan and Myanmar. NIAS sent many technical experts overseas and accepted many trainees. The NIAS Genebank has been conducting MOU-based research collaboration programs (3 to 5 years) to encourage researchers in different countries including Bhutan to survey and monitor genetic diversity of natural populations and landraces on farmers' fields. These collaborative programs include visits to Japan for research and exploration in Japan by genetic resources staff of the collaborating country.

### Field Survey in Bhutan, 2007

N. Tomooka, A. Tamang, and H. Okuizumi surveyed cereals, legumes, and their wild relatives throughout Bhutan (Fig. 1). It was carried out from September 25 to October 18, 2007. Herbarium specimens, seeds and root nodules were collected. They collected materials from farmers' fields, farmers' store and/or local markets. Information including province (Gyo), village, farmer's name, altitude, latitude, longitude, habitat, cultural practices, disease and pest, and other ecological data were recorded together with detail map of collection sites. A total of 96 seed samples were collected (Table 1).

Nine species of cultivated cereal/pseudocereals collected were *Eleusine coracana* (finger millet: Photo 1), *Fagopyrum esculentum* (common buckwheat: Photo 2), *F. tataricum* (tartary buckwheat), *Hordeum vulgare* (barley), *Oryza sativa* (rice: Photo 3), *Setaria italica* (foxtail millet: Photo 4), *Sorghum bicolor* (sorghum: Photo 5), *Triticum aestivum* (wheat), and *Zea mays* (maize: Photo 6). *E. coracana* was mainly collected from eastern and southern Bhutan. It is mainly used for producing an alcoholic drink, called "ara." Samples of *S. bicolor* were collected in Trashigang, Mongar, Sarpan and Thimphu provinces. Most of them were grown as a ratoon crop in a kitchen garden (Photo 5). The brix (sugar content) data indicates that the sorghum samples observed in

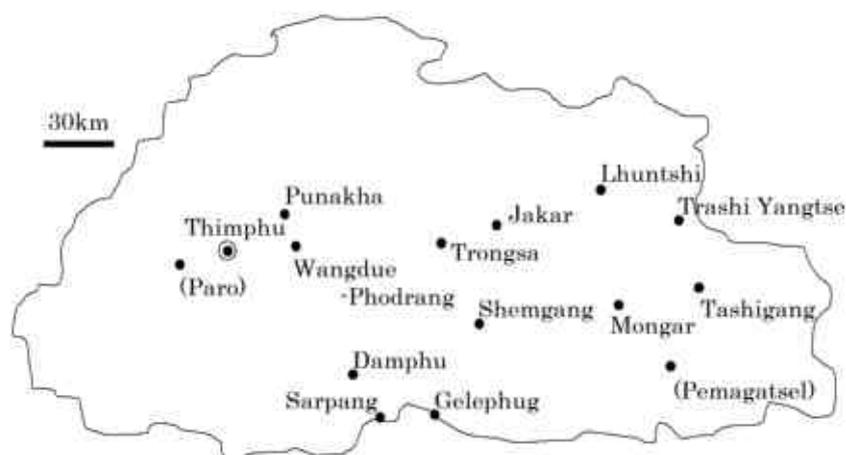


Fig. 1 Map of places explored in Bhutan.

Explorations of Paro and Pemagatse were carried out on the way to those cities.



Photo 1 *Eleusine coracana*



Photo 2 *Fagopyrum esculentum*



Photo 3 *Vigna mungo* and *V. umbellata* were planted on ridges of the terrace paddy



Photo 4 *Setaria italica*



Photo 5 *Sorghum bicolor*



Photo 6 *Zea mays*



Photo 7 Field of, *S. italica*, *E. coracana*, *S. bicolor*, *Z. mays*, and *G. max.*



Photo 8 Seed distributor who distributed seeds for the field in photo 7



Photo 9 Market in Wangdue-Phodrang



Photo 10 Commercial seeds



Photo 11 Fermented soybean seeds

Photo 12 *Vigna angularis*

Photo 13 National Biodiversity Center (NBC) in Thimphu



Photo 14 Plate of the Royal Bhutan Gene Bank



Photo 15 Gene bank facility : seed drying room and display of plant seeds

Photo 16 Gene bank facility : seed stock freezer at  $-20^{\circ}\text{C}$

Table 1. A list of crops and their wild relatives collected in Bhutan, 2007

Cereals	Samples	Legumes	Samples
<i>Echinochloa</i> sp.	1	<i>Glycine max</i>	9
<i>Eleusine coracana</i>	10	<i>Macrotyloma</i> sp.	1
<i>Fagopyrum esculentum</i>	2	<i>Phaseolus vulgaris</i>	5
<i>Fagopyrum tataricum</i>	3	<i>Phaseolus coccineus</i>	2
<i>Hordeum vulgare</i>	2	<i>Vigna angularis</i>	3
<i>Oryza sativa</i>	5	<i>Vigna angularis</i> var. <i>nipponensis</i>	22
<i>Setaria italica</i>	1	<i>Vigna mungo</i>	5
<i>Setaria</i> sp.	1	<i>Vigna radiata</i>	1
<i>Sorghum bicolor</i>	2	<i>Vigna radiata</i> var. <i>sublobata</i>	11
<i>Triticum aestivum</i>	1	<i>Vigna umbellata</i>	2
<i>Zea mays</i>	1	<i>Vigna unguiculata</i>	3
		<i>Vigna vexillata</i>	3
Sub-total	29	Sub-total	67

Bhutan have high sugar content (8.5–18.0%). One sample of maize was collected in southern Bhutan (Tsirang province). Samples of *F. esculentum*, *F. tataricum*, *H. vulgare*, and *T. aestivum* were collected in a village at relatively high altitude (ca. 2900m) where potato is the main food. Wild cereals were also collected such as *Setaria* sp. and *Echinochloa* sp. Only one sample of *Setaria italica* was found in Kanglung, Trashigang province. The same farmer cultivates *S. italica*, *E. coracana*, *S. bicolor*, *Z. mays*, and *Glycine max* in his field (Photo 7). A woman, living nearby supplied those seeds (Photo 8). Five samples of *O. sativa* (paddy rice) were collected in the eastern Bhutan (Trashigang province and on the way to Pemagatsel). Upland rice was rare in the visited areas of Bhutan. Only two farmers just started a trial cultivation of upland rice with the seed supplied from the extension workers. We had also found the commercial (improved) vegetable seeds at a market in Wangdue-Phodrang in 2006 (Photo 9, 10). Those distributions of seeds imply that native cultivars are being replaced in Bhutan.

Eight cultivated legumes collected (or observed) (Table 1) were *G. max* (soybean), *Phaseolus vulgaris* (common bean), *P. coccineus* (scarlet runner bean), *Vigna angularis* (azuki bean), *V. mungo* (black gram: Photo 3), *V. radiata* (mungbean), *V. umbellata* (rice bean: Photo 3), and *V. unguiculata* (cowpea and yard long bean) were collected. Samples of *G. max* were collected in eastern and southern Bhutan. It is eaten either as roasted mature seeds, as boiled immature seeds,

or as fermented boiled seeds (Photo 11). *P. vulgaris* is widely cultivated in Bhutan. It is usually grown together with maize. *P. coccineus* is less common and is found as a kitchen garden crop. *V. angularis* was not cultivated commonly but could be found at several sites (Photo 12). *V. mungo* was widely cultivated in eastern and southern Bhutan. This crop was growing on the ridges of paddy fields (Photo 3). One sample of mungbean was collected in a Thimpu market. It was a product of Tsholingkhar village, Tsirang province. *V. umbellata*, a close relative of azuki bean, was cultivated at an altitude ranging from 998m to 1551m, lower than azuki bean. Rice bean is cultivated in various sites such as kitchen garden, ridges of paddy fields (Photo 3) or upland fields. Three samples of *V. unguiculata* were collected. One population was occurring naturally in a grassland beside a road. It was thought to be an escaped and naturalized population, since plants in this population had an easy shattering habit.

As wild relatives of legume crops, one sample of *Macrotyloma* sp., 22 of *V. angularis* var. *nipponensis*, 11 of *V. radiata* var. *sublobata* and 3 of *V. vexillata* were collected (Table 1). *V. angularis* var. *nipponensis* and *V. radiata* var. *sublobata* were common in Bhutan. *V. vexillata* was found at four sites and their seeds could be collected at 3 of them. At all the four sites, *V. angularis* var. *nipponensis* was also found. The “Flora of Bhutan” was published by the Royal Botanic Garden, Edinburgh in 1987. In that Flora the *Leguminosae* section was compiled in Volume

1, Part 3 of this series. This book described not only wild flora but also cultivated plants in Bhutan. However, cultivated azuki bean (*V. angularis* var. *angularis*), wild azuki bean (*V. angularis* var. *nipponensis*), cultivated black gram (*V. mungo* var. *mungo*) and wild mungbean (*V. radiata* var. *sublobata*) were not listed. These taxa were new records in Bhutan.

All the seed materials collected (29 samples of 11 different cereal species and 67 samples of 12 leguminous species including wild relatives) were deposited in the Genebank, NBC, Bhutan (Photos 13-16).

### Conclusion

The survey revealed that the agriculture and people's lifestyle are being maintained in a traditional manner in Bhutan. However, the variation of native cultivars is decreasing due to import of seeds of different crops from outside. The effective survey, preservation, and use of those genetic resources are urgent themes in Bhutan. Further close collaboration based on this survey between Bhutan and Japan will be very fruitful since Bhutan's plant genetic resources have been poorly studied, as the new findings of legume crops and wild relatives were revealed.

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## 日本のジーンバンクから見たブータン

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### 要 約

日本では、我々の農業生物資源ジーンバンクにおいて、農業分野の遺伝資源について国内外の探索収集、特性評価、保存、配布、情報公開を行っている。2007年に当ジーンバンクとブータン国立生物多様性センター (NBC) との間で協同研究協定 (MOU) が締結された。これに基づき、2007年にブータンにおける植物遺伝資源の探索調査を共同で実施した。探索の結果、穀類では野生種 2 種を含む 11 種 29 点を収集した。このうちソルガムは、ブータンのジーンバンクにおけるはじめてのコレクションであった。豆類では、4 種の野生種を含む 12 種 67 点を収集した。このうちアズキ、ケツルアズキ、ヤブツルアズキ、リョクトウ祖先種は、ブータンにおける初記載であった。以上計 23 種 96 点の植物標本及び種子は、それぞれ NBC 標本室及び NBC ジーンバンクに保存した。この探索から、ブータンでは伝統的な生活様式のなかで農業が営まれる一方で、伝統的な在来品種の栽培は減少しつつあることが明らかになった。今後、ブータンの遺伝資源の探索・収集およびその保存・管理について、より緊密な連携を図ることにより、貴重な遺伝資源の効率的な保全と活用が期待される。

キーワード：植物遺伝資源, 探索, ブータン, NIAS ジーンバンク