

Original Paper

Collaborative Exploration for *Sorghum*, *Zea*, *Saccharum* and Related Wild Species in Laos, May to June, 2011

Hisato OKUIZUMI¹⁾, Chanthanom DEUANHAKSA²⁾, Shuichiro TAGANE³⁾, Yoshifumi TERAJIMA⁴⁾, Naohiro UWATOKO⁵⁾, Tomotsugu NOGUCHI¹⁾, Eri NONAKA¹⁾, Kongpanh KANYAVONG²⁾, Khemkham HONGPHAKDY²⁾, Keo INTABON¹⁾, Mitsuru GAU⁵⁾ and Akira SUGIMOTO⁴⁾

- 1) National Institute of Agrobiological Sciences, Kannondai 2-1-2, Tsukuba, Ibaraki 305-8602, Japan.
- 2) Rice and Cash Crops Research Center, National Agriculture and Forestry Research Institute, Ministry of Agriculture and Forestry, P.O. Box 811, Vientiane, Lao PDR.
- 3) Faculty of Science, Kyushu University, Fukuoka, 812-8581, Japan
- 4) Japan International Research Center for Agricultural Sciences, Ohwashi 1-1, Tsukuba, Ibaraki 305-8686, Japan
- 5) National Agriculture and Food Research Organization, Kyushu Okinawa Agricultural Research Center, Suya 2421, Koshi, Kumamoto 861-1192, Japan

Summary

The National Institute of Agrobiological Sciences (NIAS), Japan and the Rice and Cash Crop Research Center (RCCRC), National Agriculture and Forestry Research Institute (NAFRI), Lao People's Democratic Republic (Laos) have collaborated since 2006 to survey plant genetic resources under the Memorandum of Agreement (MOA). To explore and collect genetic resources in Laos, the second collaborative mission of *sorghum* was conducted from 25th May to 6th June in 2011. The main objectives of this study were to collect and conserve genetic resources of *Sorghum*, *Maize*, *Saccharum* and *Erianthus*. In addition to these species, *Setaria italica*, *Eleusine coracana* and *Amaranthus* sp. were also collected. During the survey, Vientiane, Borikhamxai and Khammouane provinces were explored.

In total, 50 samples of 10 species in 8 genera of Poaceae were collected from the explored region: 15 of *Sorghum bicolor*, 1 of *Setaria italica*, 1 of *Eleusine Coracana*, 1 of *Zea mays*, 1 of *Amaranthus* sp., 4 of *Saccharum spontaneum*, 14 of *Erianthus procerus*, 5 of *E. arundinaceus*, 4 of *E. longisetosus* and 4 of *Miscanthus floridulus*.

To evaluate their growth behavior, response to environmental stress and resistance to diseases and to share genetic resources in both two countries, these collections will be preserved in the experimental field at NAFRI, Laos.

KEY WORDS : *Sorghum*, *Setaria*, *Eleusine*, *Zea*, *Saccharum*, *Erianthus*, *Miscanthus*, Laos, NAFRI, RCCRC

Table 1. Itinerary of the survey in Laos, May to June, 2011

day	data	Exploring activity	Move (km)	Stay town
1	25 May Wed	Depart Japan and arrive in Lao PDR		Vientiane
2	26 May Thu	Vientiane → Pak Xan	135	Pak Xan
3	27 May Fri	Pak Xan → Borikhan → Thasi → Xiengleu → Thasi → Borikhan → Pak Xan → Pakkading → Pak Xan	348	Pak Xan
4	28 May Sat	Pak Xan → None Say → Bam Nasala → Vientiane	399	Vientiane
5	29 May Sun			
6	30 May Mon	Vientiane, RCCRC and surrounding area		Vientiane
7	31 May Tue			
8	1 Jun Wed	Vientiane → Vieng Kham	250	Vieng Kham
9	2 Jun Thu	Vieng Kham → Ban Namthi → Ban Phone → Ban Kohai → Lax Xao	195	Lax Xao
10	3 Jun Fri	Lax Xao → Ban Thong → Bankeo → Ban Houay Xot → Ban Hin Ngone → Vieng Kham	249	Vien Kham
11	4 Jun Sat	Vieng Kham → Thong Namy → Vientiane	180	Vientiane
12	5 Jun Sun	Depart Laos and arrive in Japan		

Introduction

The National Institute of Agrobiological Sciences (NIAS), Japan and the Rice and Cash Crop Research Center (RCCRC), National Agriculture and Forestry Research Institute (NAFRI), Lao People's Democratic Republic (Laos) have collaborated since 2006 to survey plant genetic resources under the Memorandum of Agreement (MOA). This report describes the second survey trip to investigate and collect species of *Sorghum*, *Zea*, *Saccharum* and their wild relatives in Laos.

The most important renewable fuel to replace the fossil source is considered to be bio-ethanol. On the other hand, there is a concern about increasing bio-ethanol production which may result in higher food prices, since available arable land area is limited, and compete with conventional crops for human consumption and livestock feeds. Millets such as *Sorghum* spp. are thought to be the best genetic resources for solving this problem, however, the available accessions in Laos is very limited, so that, survey of millets in Laos is challenging but required. Sugarcane is also a hopeful material for this purpose in tropical and subtropical regions. Therefore, to increase the sugarcane productivity will be an important key to reducing the above concerns. To increase the production of sugarcane, breeding is important because it enables conventional sugarcane varieties to improve resistance ability to diseases, drought, low temperature and so on. While wild relatives of sugarcane, such as *Erianthus* and *Miscanthus* are abundantly distributed in Laos. Their traits have not been yet properly evaluated. Therefore, it is expected that a high genetic variation of sugarcane and its wild relatives will be found in Laos. This report summarizes the preliminary field survey for wild sugarcane relatives including *Saccharum spontaneum* and *Erianthus* spp. in the regions of Vientiane, Borikhamxai and Khammouane.

Survey Methods

The itinerary of the survey is shown in Table 1. The collection sites are shown in Fig. 1. . A rental car was used for the field survey. Landscape of survey sites, information of investigated and collected sample traits, such as plant height, basal stem diameter and length of panicle or

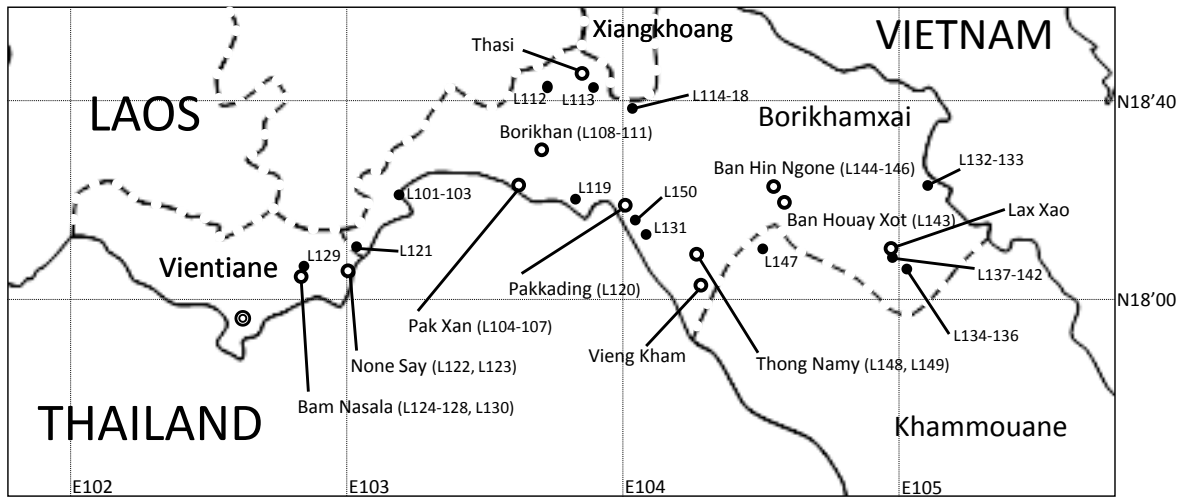


Fig. 1. Map of collection site

flower were recorded. Samples were collected when we found favorable strains in the field and a photographic record was made of the collecting sites and materials.

Results

• Borikhamxai area (26th-28th May, 2011)

On 26th May, the survey team departed from Vientiane to Pak Xan, Borikhamxai. As shown in Table 2, *Miscanthus floridulus* (L101 and L103) and *Erianthus procerus* (L102) were found on the Mekong river bank near Nong Mak Chap village. *Saccharum spontaneum* (L104) was found at the harbor of the Mekong river. *Erianthus arundinaceus* (L105 and L107) and *S. spontaneum* (L106) were collected on the Mekong river bank in Pak Xan. The car route distance was about 135 km.

The next day, 27th May, the survey started from Pak Xan. *Erianthus procerus* (L108) was found on the Houay Hen river bank near Borikhan village, and then *Erianthus longesetosus* (L109 and L111) and *E. procerus* (L110) were found near Borikhan. *Erianthus procerus* (L112) was found in Muang Huang village. *Erianthus procerus* (L113) was found on the way from Thasi to Xiengleu, and *S. spontaneum* (L114), *E. procerus* (L115), *E. longesetosus* (L116) and *E. arundinaceus* (L117 and L118) were collected beside the Choi river in Xiengleu village. On the return journey, *E. arundinaceus* (L119) was found on the Mekong river bank in Pak Xan, *E. procerus* (L120) was found at the foot of a bridge in Pakkading village. The survey team stayed one night in Pakkading village.

On the 28th May, the survey went back to Vientiane. Along the route, *E. procerus* (L121), *M. floridulus* (L122), *S. spontaneum* (L123) and *Eleusine coracana* (L124) were found. L121 and L122 grew along the roadside, L123 grew on the river bank of Mekong river in None Say village, and L124 grew in Bam Nasala village, Vientiane.

• Vientiane and surrounding areas (29th-31st May, 2011)

The survey team stayed in Vientiane from 29th to 31st. The survey started from RCCRC,

Vientiane on 29th May. In Nakhao village, Vientiane, three *Sorghum bicolor* (L125 to L127) and *Amaranthus* sp. (L128) were found and collected. *Erianthus procerus* (L129) was found in Thaxan village, Vientiane.

The next day 30th May, in Ban Phone Ngam II, Vientiane, *S. bicolor* (L130) was found.

On 31st May, the survey team stayed in RCCRC and examined the collected materials.

• Borikhamxai area 2 (1st-4th June, 2011)

On 1st June, the survey team departed Vientiane for Vieng Kham, Borikhamxai and stayed there. *Erianthus procerus* (L131) was collected at 1.5 km east of Pakkading.

The next day, the survey team started from Vieng Kham. Large colonies of *Erianthus longesetosus* (L132) and *E. procerus* (L133) were found near the Laos-Vietnam border. The survey team arrived in Lax Xao, Borikhamxai, and *S. bicolor* (L134 and L135) and *Zea mays* (L136) were found in surrounding areas.

On 3rd June, *S. bicolor* (L137) was found in a field in Ban Thong Vien Kham village. *Setaria italica* (L138) and *S. bicolor* (L139 and L140) were found in Bankeo Sen Kham village just 20 minutes after the survey team departed Ban Thong Vien Kham. On the route back from Bankeo Sen Kham to Lax Xao, *E. procerus* (L141) and *M. floridulus* (L142) were found. In addition to L137 to L142 were found in surrounding areas of Lax Xao, *S. bicolor* (L143) in Ban Houay Xot village, and three *S. bicolor* (L144, 145 and 146) populations were found in Ban Hin Ngone village and collected. The survey team went back to Vieng Kham and stayed there. On the way, *E. procerus* (L147) was found on roadside in Khammouane district.

The final day, 4th June, the survey team left for RCCRC, Vientiane via Thong Namy. *Sorghum bicolor* (L148 and L149) were found in Thong Namy village, Borikhamxai and *E. procerus* (L150) were found at 13 km east from Pakkading.

Discussion

The major investigation and collections in this survey are shown in Table 3:

1. *Sorghum bicolor* (Total collection was 15 accessions: L 125, 126, 127, 130, 134, 135, 137, 139, 140, 143, 144, 145, 146, 148 and 149) (Photos 25, 28, 32, 33, 35, 37, 38, 41-44, 46, 47, respectively).

In Laos, the postharvest season of sorghum is from May to June. So, we could obtain sorghum seeds for all collections. There were more sorghum varieties in Laos than we expected. Local names of sorghum differs from region to region and among ethnic groups in Laos. In this survey, L125, 126 and 127 were all called “Makhao Khouan” with different color such as “Kao (brown)”, “Deng (red)” and “Dam (black)”, respectively. L 134 and 135 were provided by Mr. Youa Yang and Mr. Khem Phone, respectively. Both seeds were black color, and panicle types were broom type. L 137 from Mr. Wany Sao Wang, was “bicolor” type. L 139 and L 140 were collected in Bankeo Sen Kham village. L139 was “guinea” type and L140 was “bicolor” type. L 143 was donated by Mr. Mai Mee, a Tok Taek village farmer. L 144, 145 and 146 were collected in Ban Hin Ngone, donated by farmers, Mr. Yatho, Ms. Nit and Ms. Nouan respectively. They called sorghum ‘Gon Jua’. L148 and 149 was collected in Thong Namy

Table 2. List of Collection

*L-number are collection number (refer to Table 3).

Species	Area			Total
	Vientiane	Borikhamxai	Khammouane	
<i>Sorghum bicolor</i>	L125, L126, L127, L130	L134, L135, L137, L139, L140, L143, L144, L145, L146, L148, L149		15
<i>Setaria italica</i>		L138		1
<i>Eleusine coracana</i>	L124			1
<i>Zea mays</i>		L136		1
<i>Amaranthus</i> sp.	L128			1
<i>Erianthus procerus</i>	L129	L102, L108, L110, L112, L113, L115, L120, L121, L131, L133, L141, L150	L147	14
<i>Erianthus arundinaceus</i>		L105, L107, L117, L118, L119		5
<i>Erianthus longesetosus</i>		L109, L111, L116, L132		4
<i>Saccharum spontaneum</i>	L123	L104, L106, L114		4
<i>Miscanthus floridulus</i>	L122	L101, L103, L142		4
Total	9	40	1	50

village.

Sorghum is known by various names in Laos; Makhao Khouang Kao, Makhao Khouang Deng, Makhao Khouang Dam, Khao Fang, Nga Xang Khoua, Nga Xang Nham, Tok Taek, Gon Jua and Quavntsuas Mhoob. This suggests that sorghum is divergent with various genotypes and preserved at local level (family, settlement, village, etc.). Local people can select seeds they want depending on their purpose and seasons.

2. *Setaria italica* (L 138) (Photo 36).

Setaria italica was donated by a farmer, Ms. Khen in Bankeo Sen Kham village. The panicle length reached 30 cm. *Setaria italica* was called 'Khao Fang', which was the same name as sorghum in the different village while Ms. Khen distinguished sorghum as "Nga Xang Khoua". Farmers mixed them with rice when they eat.

3. *Eleusine coracana* (L 124) (Photo 24).

Eleusine coracana was found in Bam Nasala village, Vientiane, donated by Ms. Hueher. She called it 'Pia'. Seeds were crushed and steamed when eaten.

4. *Zea mays* (L 136) (Photo 34).

Zea mays was only found in Ban Kohai village, and called 'Sali'. It was donated by Ms. Vue, and has a yellowish color.

5. *Amaranthus* sp. (L128) (Photo 26).

It is called 'Phakhom' - and its leaves are used in a chicken soup.

6. *Erianthus* spp.

Erianthus wild species are important for conservation as genetic resources and their traits need to be evaluated. This genus is classified as a phylogenetically different group from other

Saccharum complex genera including *Saccharum*, *Miscanthus*, *Sclerostachya* and *Narenga*. Three species of *Erianthus* are native in Laos.

6-1. *Erianthus procerus* (Total collection was 14 accessions: L 102, 108, 110, 112, 113, 115, 120, 121, 129, 131, 133, 141, 147 and 150) (Photos 2, 8, 10, 12, 13, 15, 20, 21, 27, 29, 31, 39, 45, 48).

This species was found in most widely and abundantly in the surveyed areas this time.

6-2. *E. arundinaceus* (Total collection was 5 accessions: L 105, 107, 117, 118 and 119) (Photos 5, 7, 17-19).

This species was found only in wet environments such as stream beds and riverbanks, and was not found in dry land area in the region surveyed.

6-3. *E. longesetosus* (Total collection was 4 accessions: L 109, 111, 116 and 132) (Photos 9, 11, 16, 30).

This species is normally found in disturbed slopes along the road, in the mountainous areas. We did not see this species in lowland areas of Vientiane.

7. *Saccharum spontaneum* (Total collection was 4 accessions: L 104, 106, 114 and 123) (Photos 4, 6, 14, 23).

This species is usually found in wet habitats such as riverbanks and beside rice fields. L104 grew in concrete at a harbor. They will be grown in the same field with *Erianthus* in RCCRC using similar growing method and management.

8. *Miscanthus floridulus* (Total collection was 4 accessions: L 101, 103, 122 and 142) (Photos 1, 3, 22, 40).

On the previous survey, *M. floridulus* was found only at attitudes of over 400 m. But on this survey, they were found at lower altitudes of between 152 and 155 m. In Nong Mak Chap village, it was called 'Oi Niem'.

Historically, high sugar yield has been improved for sugarcane.

Therefore, adaption to stressed environments with high yielding ability (fiber and sugar), sprouting ability for the continuous ratoonning (it is effective for the minimization of the liquidity of the sediment discharge and the soil) and adaptation to areas of low rainfall have not been improved.

It seems that the improvement of these characteristics are an important research area. The characteristic introduction of sugarcane wild relatives (high tiller character) and *Erianthus* (deep rooted ability) is important for sugarcane improvement. It was impossible to use intergeneric hybrid in a current sugar manufacture industry, until now. However, Ohara from Asahi GHD developed a necessary processing technology (Ohara *et al.* 2012). In conclusion, in addition to disease resistance, drought tolerance and low temperature adaptability, it is important to use these genetic resource for a rapid improvement of high yielding ability and sprouting ability for the continuous ratoonning.

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References

- Berval, R. D. (1959) Kingdom of Laos. *Bontemps Co., Ltd*, Limoges, France, 506pp.
- Hodkinson, T. R., *et al.* (2002) Phylogenetics of *Miscanthus*, *Saccharum* and related genera based on DNA sequences from ITS nuclear ribosomal DNA and plastid *trnL* intron and *trnL-F* intergenic spacers. *Journal of Plant Research*, 115:381-392.
- Ohara, S., *et al.* (2012) Rethinking the cane sugar mill by using selective fermentation of reducing sugars by *Saccharomycea dairenensis*, prior to sugar crystallization. *Biomass and Bioenergy*, 42:78-85.
- Ohara, S., *et al.* (2013) Development of the novel sugar-ethanol production system introducing the selective ethanol fermentation of reducing sugars prior to sugar crystallization. *Proc. Int. Soc. Sugar Cane Tech.*, vol. 28.
- Okada M. and H. Mitsuhashi. (2002) Newly revised illustrated medical plants of the world. *Hokuryukan*, Tokyo (in Japanese), 892pp.
- Okuizumi, H., *et al.* (2011) Collaborative Exploration of *Sorghum*, *Zea*, *Saccharum* and Their Relative Wild Genetic Resources in Laos, January, 2011. *Annual Report on Exploration and Introduction of Plant Genetic Resources*, 27:129-155.
- Ponragdee, W., *et al.* (2013) New type of high yielding sugarcane with lower sugar and higher fibre content suitable for stable co-production of sugar and ethanol in northeast Thailand. *Proc. Int. Soc. Sugar Cane Tech.*, vol. 28.
- Simmonds, N. W., (1976) Evolution of Crop Plants. *Longman*, London and New York, 339pp.
- Tagane, S., *et al.* (2012) Characterization and taxonomical note about Thai *Erianthus* germplasm collection: the morphology, flowering phenology and biogeography among *E. procerus* and three types of *E. arundinaceus*. *Genet. Res. Crop Evol.*, 59:769-781.
- Zeven, A. C. and P. M. Zhukovsky (1975) Dictionary of cultivated plants and their centres of diversity excluding ornamentals, forest trees, and lower plants. *Centre for Agricultural Publishing and Documentation*, Wageningen, 219pp.
- Zhang Y. W., *et al.* (2002) Sequence variation of *rbcl* gene and evolution of *Saccharum* and relative species. *Acta Metallurgica Sinica*, 24(01):1-3.

和文摘要

今回、農業生物資源研究所とラオス国立農林研究所 (NAFRI) の間で 2006 年に締結した共同研究協定に基づいて行われた 2011 年度ジーンバンク事業のラオスにおける植物遺伝資源調査について報告する。調査はソルガムの二回目の共同調査活動として 2011 年 5 月 25 日～6 月 6 日に、ビエンチャン、ポリナムサイ、およびカンモウアンの 3 つの地区に跨がり実施された。

今回の調査の主な目標はソルガムの現地調査であったが、ほかにエリアンサス、トウモロコシ、サトウキビ近縁種も対象とした。合計 50 点について生息地での調査を行ったほか、種子及び栄養体の茎、株も採取した。これらのうち種子は十分乾燥させた後、NAFRI 傘下の稲・換金作物研究センター (RCCRC) 種子庫 (5℃) で保存した。また、エリアンサスについては RCCRC の圃場にて遺伝資源として栽培・維持していく計画である。

Table 3. A passport data of collection materials

No.	Coll. No.	JP No.	Coll. Date	Species name	Status* ¹	Local name	Sample* ²	Locality (Province, Village)	Latitude	Longitude	Altitude (m)	Condition* ³	Collection	Remarks
L101	2011Lao101	249526	26 May	<i>Miscanthus floridulus</i>	1	oi niem	In	Nong Mak Chap	N18-25-43.3	E103-16-53.3	155	3-2-3-2-3	Vegetative	Culm length : 2.7 m, Plant height : 3.5 m Basal stem diameter : 11mm
L102	2011Lao102	249527	26 May	<i>Erianthus procerus</i>	1	-	In	Nong Mak Chap	N18-25-41.1	E103-16-42.6	152	3-2-3-2-3	Vegetative	Culm length : 1.5 m, Plant height : 3.1 m Basal stem diameter : 20 mm
L103	2011Lao103	249528	26 May	<i>Miscanthus floridulus</i>	1	-	In	Nong Mak Chap	N18-25-41.1	E103-16-42.6	152	3-1-2-2-3	Vegetative	Culm length : 1.9 m, Panicle length : 0.6 m Plant height : 2.5 m, Basal stem diameter : 9 mm
L104	2011Lao104	249529	26 May	<i>Saccharum spontaneum</i>	1	nor xeng	In	Pak Xan	N18-23-21.2	E103-38-31.7	155	2-2-0*-0*-4	Vegetative	Culm length : 1.9 m, Plant height : 3.2 m Basal stem diameter : 15 mm *Condition : Concrete
L105	2011Lao105	249530	26 May	<i>Erianthus arundinaceus</i>	1	-	In	Pak Xan	N18-22-35.6	E103-39-31.3	156	2-2-2-2-3	Vegetative	Culm length : 3.0 m, Plant height : 3.3 m Basal stem diameter : 13 mm
L106	2011Lao106	249531	26 May	<i>Saccharum spontaneum</i>	1	-	In	Pak Xan	N18-22-33.9	E103-39-31.8	148	2-2-3-1-3	Vegetative	Culm length : 1.6 m, Plant height : 2.7 m Basal stem diameter : 9 mm
L107	2011Lao107	249532	26 May	<i>Erianthus arundinaceus</i>	1	-	In	Pak Xan	N18-22-33.9	E103-39-31.8	148	2-2-3-1-3	Vegetative	Culm length : 1.3 m, Plant height : 2.0 m Basal stem diameter : 12 mm
L108	2011Lao108	249533	27 May	<i>Erianthus procerus</i>	1	-	In	Borikhan	N18-33-10.5	E103-42-27.2	164	3-2-2-2-3	Vegetative	Culm length : 2.2 m, Plant height : 4.1 m Basal stem diameter : 16 mm
L109	2011Lao109	249534	27 May	<i>Erianthus longesetosus</i>	1	-	In	Borikhan	N18-34-10.8	E103-44-08.7	227	5-2-4-2-3	Vegetative	Culm length : 1.3 m, Plant height : 1.8 m Basal stem diameter : 6 mm
L110	2011Lao110	249535	27 May	<i>Erianthus procerus</i>	1	-	In	Borikhan	N18-36-13.9	E103-43-29.0	185	5-2-4-2-3	Vegetative	Culm length : 3.8 m, Panicle length : 1.0 m Plant height : 4.8 m, Basal stem diameter : 18 mm
L111	2011Lao111	249536	27 May	<i>Erianthus longesetosus</i>	1	-	In	Borikhan	N18-36-13.9	E103-43-29.0	185	5-2-4-2-3	Vegetative	Culm length : 2.9 m, Plant height : 3.5 m Basal stem diameter : 14 mm
L112	2011Lao112	249537	27 May	<i>Erianthus procerus</i>	1	-	In	Muang Huang	N18-45-19.5	E103-45-01.5	231	5-2-2-2-2	Vegetative	Culm length : 2.6 m, Plant height : 4.6 m Basal stem diameter : 17 mm
L113	2011Lao113	249538	27 May	<i>Erianthus procerus</i>	1	-	In	Thasi to Xlengleu	N18-44-27.6	E103-56-58.7	233	5-1-1-3-2	Vegetative	Culm length : 2.7m, Plant height : 4.7 m Basal stem diameter : 18 mm
L114	2011Lao114	249539	27 May	<i>Saccharum spontaneum</i>	1	-	In	Xangleu	N18-42-15.3	E104-03-47.4	301	2-1-2-1-2	Vegetative	Culm length : 1.3 m, Plant height : 2.4 m Basal stem diameter : 9 mm
L115	2011Lao115	249540	27 May	<i>Erianthus procerus</i>	1	-	In	Xangleu	N18-42-15.3	E104-03-47.4	301	2-2-3-2-2	Vegetative	Culm length : 0.6 m, Plant height : 2.0 m Basal stem diameter : 15 mm
L116	2011Lao116	249541	27 May	<i>Erianthus longesetosus</i>	1	-	In	Xangleu	N18-41-26.7	E104-03-38.4	466	5-2-3-2-2	Vegetative	Culm length : 1.7 m, Plant height : 2.2 m Basal stem diameter : 7 mm
L117	2011Lao117	249542	27 May	<i>Erianthus arundinaceus</i>	1	-	In	Xeingie	N18-41-21.8	E104-02-17.1	277	2-2-2-2-2	Vegetative	Culm length : 3.0 m, Plant height : 4.7 m Basal stem diameter : 25 mm
L118	2011Lao118	249543	27 May	<i>Erianthus arundinaceus</i>	1	-	In	Xeingie	N18-41-21.8	E104-02-17.1	277	2-2-2-2-2	Vegetative	Culm length : 3.1 m, Plant height : 4.5 m Basal stem diameter : 22 mm
L119	2011Lao119	249544	27 May	<i>Erianthus arundinaceus</i>	1	-	In	Pakxan to Pakkading	N18-20-29.1	E103-49-22.9	158	2-2-2-2-2	Vegetative	Culm length : 4.5 m, Plant height : 5.5 m Basal stem diameter : 21 mm

Table 3 (Continued).

No.	Coll. No.	JP No.	Coll. Date	Species name	Status* ¹	Local name	Sample* ²	Locality (Province, Village)	Latitude	Longitude	Altitude (m)	Condition* ³	Collection	Remarks
L120	2011Lao120	249545	27 May	<i>Erianthus procerus</i>	1	-	In	Pakkading	N18-19-30.7	E103-59-45.0	164	2-2-2-3-2	Vegetative	Culm length : 3.3 m, Plant height : 5.0 m Basal stem diameter : 15 mm
L121	2011Lao121	249546	28 May	<i>Erianthus procerus</i>	1	-	In	Say Savong	N18-12-42.6	E103-04-48.1	175	3-1-2-2-2	Vegetative	Culm length : 2.6 m, Plant height : 4.3 m Basal stem diameter : 15 mm
L122	2011Lao122	249547	28 May	<i>Miscanthus floridulus</i>	1	-	In	Ban None Say	N18-06-57.0	E103-03-31.2	154	2-1-N-3-2	Vegetative	Culm length : 2.9 m, Plant height : 3.4 m Basal stem diameter : 5 mm
L123	2011Lao123	249548	28 May	<i>Saccharum spontaneum</i>	1	-	In	None Say	N18-06-10.7	E103-03-58.8	156	2-2-2-1-2	Vegetative	Culm length : 2.0 m, Plant height : 3.4 m Basal stem diameter : 15 mm
L124	2011Lao124	249549	28 May	<i>Eleusine coracana</i>	4	Pia	In	Vientiane, Bam Nasala	N18-07-55.8	E102-53-54.5	175	3-1-2-5-3	Seed	by Ms. Huaher
L125	2011Lao125	249550	29 May	<i>Sorghum bicolor</i>	4	Makhao Khouang Kao	In	Vientiane, Nakhao	N18-06-44.0	E102-51-12.7	157	3-1-1-4-3	Seed	Brown, by Mr. Sonesay
L126	2011Lao126	249551	29 May	<i>Sorghum bicolor</i>	4	Makhao Khouang Deng	In	Vientiane, Nakhao	N18-06-44.0	E102-51-12.7	157	3-1-1-4-3	Seed	Red
L127	2011Lao127	249552	29 May	<i>Sorghum bicolor</i>	4	Makhao Khouang Dam	In	Vientiane, Nakhao	N18-06-44.0	E102-51-12.7	157	3-1-1-4-3	Seed	Black
L128	2011Lao128	249553	29 May	<i>Amaranthus</i> sp.	4	Phakhom	In	Vientiane, Nakhao	N18-06-44.0	E102-51-12.7	157	3-1-1-4-3	Seed	Plant height : 1.5 m
L129	2011Lao129	249554	29 May	<i>Erianthus procerus</i>	1	-	In	Thaxan	N18-11-33.6	E102-54-12.0	164	3-1-2-3-3	Vegetative	Culm length : 2.2 m, Panicle length : 1.0 m Plant height : 4.0 m Basal stem diameter : 21 mm
L130	2011Lao130	249555	30 May	<i>Sorghum bicolor</i>	4	Khao Faong	In	Ban Phone Ngam II	N/A	N/A	N/A	3-1-1-4-2	Seed	
L131	2011Lao131	249556	1 Jun	<i>Erianthus procerus</i>	1	-	In	1.5 km east from Pakkading	N18-16-54.6	E104-08-52.6	175	3-2-3-3-2	Vegetative	Culm length : 2.0 m, Panicle length : 0.8 m Plant height : 3.5 m Basal stem diameter : 15 mm
L132	2011Lao132	249557	2 Jun	<i>Erianthus longesetosus</i>	1	-	In		N18-22-49.2	E105-09-20.4	714	6-2-3-4-3	Vegetative	Culm length : 2.0 m, Plant height : 2.6 m Basal stem length : 10 mm
L133	2011Lao133	249558	2 Jun	<i>Erianthus procerus</i>	1	-	In		N18-21-56.3	E105-08-05.9	557	6-2-3-1-3	Both	Culm length : 2.2 m, Panicle length : 1.0 m Plant height : 3.2 m Basal stem diameter : 15 mm
L134	2011Lao134	249559	2 Jun	<i>Sorghum bicolor</i>	4	-	In	Ban Namthi	N18-07-59.4	E105-01-12.7	516	5-2-2-3-2	Seed	Race : bicolor Broom, Black, by Mr. Youa Yang (Mon)
L135	2011Lao135	249560	2 Jun	<i>Sorghum bicolor</i>	4	Khao Fang	In	Ban Phone Xay	N18-06-51.4	E105-02-05.0	497	5-2-2-3-2	Seed	Race : bicolor Broom, Black, by Mr. Khem Phone (Kumu)
L136	2011Lao136	249561	2 Jun	<i>Zea mays</i>	-	Sali	In	Ban Kohai	N18-05-09.9	E105-02-33.4	509	5-2-2-3-2	Seed	Yellowish, by Ms. Vue (Mon)
L137	2011Lao137	249562	3 Jun	<i>Sorghum bicolor</i>	4	-	In	Ban Thong Vien Kham	N18-14-35.7	E104-55-58.2	503	5-2-2-4-3	Seed	Race : bicolor by Mr. Wany Sao Wang

Table 3 (Continued).

No.	Coll. No.	JP No.	Coll. Date	Species name	Status* ¹	Local name	Sample* ²	Locality (Province, Village)	Latitude	Longitude	Altitude (m)	Condition* ³	Collection	Remarks
L138	2011Lao138	249563	3 Jun	<i>Setaria italica</i>	4	Khao Fang	In	Bankeo Sen Kham	N18-17-54.9	E104-55-02.2	527	3-1-2-4-3	Seed	Culm length : 1.5 m, Panicle length : 30 cm Basal stem diameter : 7 mm, by Ms. Khen (Nhor)
L139	2011Lao139	249564	3 Jun	<i>Sorghum bicolor</i>	4	Nga Xang Khoua	In	Bankeo Sen Kham	N18-17-54.9	E104-55-02.2	527	3-1-2-4-3	Seed	Race : guinea, Goose neck Plant height : 3 m
L140	2011Lao140	249565	3 Jun	<i>Sorghum bicolor</i>	-	Nga Xang Nham	In	Bankeo Sen Kham	N18-17-54.9	E104-55-02.2	527	3-1-2-4-3	Seed	Race : bicolor
L141	2011Lao141	249566	3 Jun	<i>Erianthus procerus</i>	1	-	In		N18-13-15.6	E104-56-30.2	560	5-1-3-2-2	Both	Culm length : 3.5 m, Panicle length : 0.9 m Plant height : 4.2 m, Basal stem diameter : 15 mm
L142	2011Lao142	249567	3 Jun	<i>Miscanthus floridulus</i>	1	-	In		N18-13-15.6	E104-56-30.2	560	5-1-3-2-2	Both	Culm length : 2.8m, Panicle length : 0.7m Plant height : 3.5m, Basal stem diameter : 13mm
L143	2011Lao143	249568	3 Jun	<i>Sorghum bicolor</i>	4	Tok Taek	In	Ban Houay Xot	N18-20-54.6	E104-30-18.6	406	5-2-3-4-3	Seed	Race : bicolor Panicle length : 0.6 m, Plant height : 3 m by Mr. Mai Mee
L144	2011Lao144	249569	3 Jun	<i>Sorghum bicolor</i>	4	Gon Jua	In	Ban Hin Ngone	N18-23-16.9	E104-28-47.0	355	5-2-3-4-3	Seed	Race : durra, by Mr. Yatho
L145	2011Lao145	249570	3 Jun	<i>Sorghum bicolor</i>	4	-	In	Ban Hin Ngone	N18-23-16.9	E104-28-47.0	355	5-2-3-4-3	Seed	Race : bicolor Plant height : 3 m, by Ms. Nit
L146	2011Lao146	249571	3 Jun	<i>Sorghum bicolor</i>	4	-	In	Ban Hin Ngone	N18-23-16.9	E104-28-47.0	355	5-2-3-4-3	Seed	Race : durra Plant height : 3 m, by Ms. Nouan
L147	2011Lao147	249572	3 Jun	<i>Erianthus procerus</i>	1	-	In		N18-10-47.8	E104-29-53.6	273	5-4-3-5-2	Both	Culm length : 4.3 m, Panicle length : 0.7 m Plant height : 5.0 m Basal stem diameter : 20 mm
L148	2011Lao148	249573	4 Jun	<i>Sorghum bicolor</i>	4	Quavntsuas mhoob	In	Thong Namy	N18-10-28.1	E104-14-08.7	157	3-2-1-3-3	Seed	Race : bicolor, Black Plant height : 2.5 - 3 m, by Ms. Niam Va Lauj
L149	2011Lao149	249574	4 Jun	<i>Sorghum bicolor</i>	4	-	In	Thong Namy	N18-10-28.1	E104-14-08.7	157	3-2-1-3-3	Seed	Race : bicolor, Brown (Yellow) Plant height : 2.5 - 3 m
L150	2011Lao150	249575	4 Jun	<i>Erianthus procerus</i>	1	-	In	13 km east from Pakkading	N18-17-48.1	E104-05-24.2	149	3-2-3-1-2	Both	Culm length : 3.4 m, Panicle length : 1.1 m Plant height : 4.5 m Basal stem diameter : 12 mm

*1) 1; Wild, 4; Landrace

*2) In; Individual, P; Population (seeds)

*3) Topography-Site-Stoniness-Soil texture-Drainage

Topography 1; swamp, 2; flood plain, 3; plain level, 4; undulation, 5; hilly, 6; mountainous, 7; other (specify)

Site 1; level, 2; slope, 3; summit, 4; depression

Stoniness 1; none, 2; low, 3; medium, 4; rocky

Soil texture 1; sand, 2; loam, 3; clay, 4; silt, 5; highly organic

Drainage 1; poor, 2; moderate, 3; good, 4; excessive



Photo 1. *M. floridulus* (L101)



Photo 2. *E. procerus* (L102)



Photo 3. *M. floridulus* (L103)



Photo 4. *S. spontaneum*(L104)



Photo 5. *E. arundinaceus* (L105) on
Mekong river bank



Photo 6. *S. spontaneum* (L106) on
Mekong river bank



Photo 7. *E. arundinaceus* (L107) on
Mekong river bank



Photo 8. *E. procerus* (L108) on Houay Hen
river bank



Photo 9. *E. longesetosus* (L109)



Photo 10. *E. procerus* (L110)



Photo 11. *E. longesetosus* (L111)



Photo 12. *E. procerus* (L112)



Photo 13. *E. procerus* (L113)



Photo 14. *S. spontaneum* (L114) on Choi river bank



Photo 15. *E. procerus* (L115) on Choi river bank



Photo 16. *E. longesetosus* (L116) on Choi river bank



Photo 17. *E. arundinaceus* (L117), it was hairy type



Photo 18. *E. arundinaceus* (L118), it was hairy type



Photo 19. *E. arundinaceus* (L119), it was hairless type



Photo 20. *E. procerus* (L120) on the foot of bridge of Mekong river



Photo 21. *E. procerus* (L121)



Photo 22. *M. floriduls* (L122)



Photo 23. *S. spontaneum* (L123) on Mekong river bank



Photo 24. *Eleusine coracana* (L124) with farmer family



Photo 25. *S. bicolor* (brown; L125, red; L126, black and discolor; L127)



Photo 26. *Amaranthus* sp. (L128)



Photo 27. *E. procerus* (L129)



Photo 28. *S. bicolor* (L130)



Photo 29. *E. procerus* (L131)



Photo 30. *E. longesetosus* (L132)



Photo 31. *E. procerus* (L133) on Mekong river bank



Photo 32. *S. bicolor* (L134)



Photo 33. *S. bicolor* (L135)



Photo 34. *Zea mays* (L136)



Photo 35. *S. bicolor* (L137)



Photo 36. *Setaria italica* (L138)



Photo 37. *S. bicolor* (L139)



Photo 38. *S. bicolor* (L140)



Photo 39. *E. procerus* (L141)



Photo 40. *M. floridulus* (L142)



Photo 41. *S. bicolor* (L143)



Photo 42. *S. bicolor* (L144)



Photo 43. *S. bicolor* (L145)



Photo 44. *S. bicolor* (L146)



Photo 45. *E. procerus* (L147)



Photo 46. *S. bicolor* (L148)



Photo 47. *S. bicolor* (L149)



Photo 48. *E. procerus* (L150)