Ecotypes of Indigenous Wild Grasses, Wild Legumes and Settled Forage Crops in Japan

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1. Introduction

Forage grasses and wild grasses are botanically not different, though these terms are conveniently used according to types of utilization. Most of forage grasses of temperate types were selected from wild grasses in Europe and Near East for feeding livestock in a long history of animal husbandry. Most of tropical forage grasses still exist naturally as wild grasses in Africa. Rhodesgrass, guineagrass, and other cultivated species were established in Africa as landraces adapted to various local conditions through artificial pressures, such as harvesting seeds, cultivating and utilization for forage by local peoples. Then, they became modern forage grasses by scientific breeding.

Forage crops in Japan have been introduced for the past 140 years. Wild grasses and legumes in Japan still remain in a primitive stage and are not improved towards forage crops, because they are utilized for feeding livestock without artificial pressure, such as harvesting seed and cultivation, for more than one thousand and some hundred years.

2. Ecotypes of forage crops in Japan

An ecotype of a crop is defined as a population belonging to a genetically uniform group which has been established in adaption to different environmental conditions or natural stresses, such as low or high temperature, deficiency or excess of water, adverse soils, and artificial stresses such as utilizing system through a long history of cultivation.

Ecotypes of indigenous wild grasses and legumes in Japan have been formed in each place where these grasses and legumes grow. The term of ecotypes is used in Japan not only for a population in grasslands or roadside in northern Japan including Hokkaido which has a long history of planting, but also for a population of barely surviving clones in pastures for less than 40 years of cultivation.

Forage crops, such as orchardgrass, timothy, and red clover, have established many perennial landraces in Hokkaido and northern parts of the major island of Japan, where these forage crops were introduced about 140 years ago. An annual type of Italian ryegrass has also established landraces by repeated harvesting of seed at various places.

At the early stage of forage crop breeding in Japan, these ecotypes of settled forage crops played an important role as breeding materials. Many new cultivars were developed from these materials as shown in Table 1.

For more efficient utilization of ecotypes of settled forage crops in Japan, a new research project was implemented from 1984 to 1986 for exploration and collection of ecotypes from various sites in different climatic and natural-historical conditions throughout Japan, and their characteristics were evaluated from plant breeders' point of view, because these valuable ecotypes have been endangered by the introduction of new varieties from U.S.A. and Europe.

In this project, the whole area of Japan was divided into ten districts, namely, Hokkaido, Tohoku, Kanto, Tosan, Tokai, Hokuriku, Kinki, Chugoku, Shikoku, and Kyushu-Okinawa. The National Grassland Research Institute, four national regional agricultural experiment stations and two prefectural agricultural experiment stations participated in the project. Objective species of this project were orchardgrass (*Dactylis glomerata* L.), tall fescue (*Festuca arundinacea* SCHREB.), timothy (*Phleum pratense* L.), perennial ryegrass (*Lolium perenne* L.), Italian ryegrass (*Lolium multiflorum* LAM.), rhodesgrass (*Chloris gayana* KUNTH) and other species of Gramineae, and nine species from Leguminosae including alfalfa (*Medicago sativa* L.), white clover (*Trifolium repens* L.), red clover (*Trifolium pratense* L.). The total number of accessions collected by this project reached 1,400 or 18 species from 800 sites.

All the data on exploration were put into the database by 'd-BASEⅢ' for personal computers. The database included location of sites, altitude, soil type, topography, ecological condition, sample type (seed or clone), date and collector's name. The number of ecotypes collected in this project is shown in Table 2. These figures may indicate approximate numbers of existing ecotypes for each species in Japan. The ecotypes collected in this project are being evaluated from plant breeders' point of view. The results for some major districts in this project are summarized below.

1) Hokkaido district (cool region)

Forage crops were introduced to Hokkaido more than 140 years ago. At present, the grassland area in Hokkaido amounts to about 65 percent of the whole grassland area in Japan. The number of accessions from Hokkaido was 137. This is rather small in comparison with the total number in Japan. One reason for this is the precise judgment of ecotypes by collectors in Hokkaido, and the other is exclusion of timothy from the collection in Hokkaido.

Table 1 New cultivars developed from landraces and ecotypes

Grass species	Cultivar name	Origin	Distinct traits
Orchardrass	Kitamidori	Hokkaido landrace	Early, Cold rasistance
Timothy	Senpoku	Hokkaido landrace	Leafy, High yield
Italian ryegrass	Waseaoba	Ecotype from Tottori Ani Breed Sta.	Early
Tallfescue	Hokuryo	Hokkaido Agr. Res. Cent	Late, Good intake

Table 2 Number of ecotypes collected from respective districts

District / Species	Hokkaido	Tohoku	Kanto	Tosan	Tokai	Hokuriku	Kinki	Chugoku	Shikoku	Kyushu	Total
Orchardgrass	39	33	18	9	7	21	3	36	7	90	263
Tallfescue	9	30	7	1	1	21	1	43	9	143	265
Italian ryegrass	0	12	0	0	1	51	1	56	12	43	176
Perennial ryegras	3	0	1	0	0	4	1	5	1	3	18
Timothy	0	20	0	2	0	2	0	0	0	4	28
Rhodesgrass	0	0	0	0	4	0	0	0	0	154	158
Red clover	44	30	9	0	3	5	1	30	4	20	146
White clover	21	35	0	1	1	8	1	28	14	87	196
Alfalfa	17	1	10	21	15	7	1	9	1	0	82
Others	4	0	0	0	1	0	0	0	0	32	37
Total	137	161	45	34	33	119	9	207	48	576	1,369

As shown in Table 3 and 4, 83 percent of accessions were collected from grasslands, and 13 percent were from roadside. Moreover, 90 percent of accessions were collected from sites in the altitude of less than 300m. Of them 74 percent were from sites below 200m indicating that grasslands are developed in low-altitude areas in Hokkaido.

2) Hokuriku district (snowy region)

As most farm lands in Hokuriku district are paddy fields, the area of grassland and the number of cattle for dairy farming are limited. The biggest part (more than 40 percent) of accessions, therefore, was Italian ryegrass which was planted annually to paddy field during winter by dairy farmers. Seventy percent of them were collected from sites in the altitude of less than 200m.

3) Chugoku and Shikoku district (temperate region)

Dominant grass species collected in Chugoku and Shikoku district was Italian ryegrass with 70 accessions, which was followed by tall fescue and orchardgrass. Among legume species collected, ecotypes of white clover and red clover were about 40 each, but those of alfalfa were only two. Eighty percent of accessions were collected from waste grasslands(110 accessions) and roadside (94 accessions), and 60 percent were from sites below the altitude of 300m, whereas less than 5 percent were from the altitude of more than 700m.

Italian ryegrass is distributed widely in this region up to coastal area and river side. Some of them were differentiated into a type of low plant height and a few panicle number.

4) Kyushu-Okinawa district (warm region)

From this district, 575 accessions of 17 species were collected. Of them, 419 were temperate type, and 156 were tropical type. Especially, 80 percent of accessions from Okinawa belonged to the tropical type. Fifty percent of accessions in Kyushu were collected from grasslands, and 32 percent were from roadside. Accordingly, tall fescue adapted well to warm region, white clover and orchardgrass were main accessions from Kyushu.

Table 3 Number of accessions collected at different land categories in Hokkaido

Species \ Land category	Grassland	Arable land	Roadside	Forest	River side	Others	Total
Alfalfa	16	1	0	0	0	0	17
Red clover	29	2	15	0	2	0	48
White clover	20	0	1	0	0	0	21
Orchardgrass	37	0	1	1	0	0	39
Tallfescue	7	0	1	0	0	1	9
Perennial ryegrass	3	0	0	0	0	0	3
Total	112	3	18	1	2	1	137

Table 4 Number of accessions collected at different altitude in Hokkaido

Species \ Altitude	0 ~	100 ~	200 ~	300 ~	400 ~	500 ~	600 ~	700m	Total
Alfalfa	10	3	2	1	0	0	1		17
Red clover	13	19	6	4	5	1	0		48
White clover	11	7	2	1	0	0	0		21
Orchardgrass	20	10	8	1	0	0	0		39
Tallfescue	5	2	2	0	0	0	0		9
Perennial ryegrass	2	0	1	0	0	0	0		3
Total	61	41	21	7	5	1	1		137

Table 5 Number of accessions collected at different altitude in Hokuriku

Species \ Altitude	0 ~ 50	50 ~ 100	100 ~ 200	200 ~ 500	500 ~ 1000	1000 ~ 1500m	Total
Orchardgrass	9	3	1	4	3	1	21
Tallfescue	6	3	0	2	6	2	19
Italian ryegrass	41	6	1	2	0	0	50
Perennial ryegrass	0	0	0	1	1	1	3
Timothy	0	0	0	2	0	0	2
Red clover	2	0	0	1	1	1	5
White clover	1	0	0	2	2	1	6
Alfalfa	5	2	0	0	0	0	7
Total	64	14	2	14	13	6	113

Table 6 Number of accessions collected at different land categories in Chugoku-Shikoku district

Species \ Land category	Waste grassland	Past cattle market	River side	Coastal area	Roadside	Others	Total
Italian ryegrass	18	5	10	5	24	8	70
Perennial ryegrass	5	0	0	0	2	0	7
Tallfescue	25	2	3	3	19	1	53
Orchardgrass	25	1	0	0	18	0	44
Red clover	16	1	1	0	16	1	35
White clover	19	5	3	0	15	1	43
Alfalfa	2	0	0	0	0	0	2
Total	110	14	17	8	94	11	254

Table 7 Number of accessions collected in Kyushu-Okinawa district

Species / District	Temperate type									Tropical type			Grand total
	Orchardgrass	Tall fescue	Italian ryegrass	Perennial ryegrass	Timothy	Red clover	White clover	Others	Sub total	Rhodesgrass	Others	Sub total	
Northern Kyushu	24	26	12	1	0	9	35	10	117	0	0	0	117
Mid Kyushu	41	70	16	1	4	9	19	0	160	1	0	1	161
Southern Kyushu	23	41	14	1	0	2	22	19	122	7	3	10	132
Okinawa islands	2	6	1	0	0	0	11	0	20	145	0	145	165
Total	90	143	43	3	4	20	87	29	419	153	3	156	575

Table 8 Number of accessions collected at different land categories in Kyushu

Land category / District	Artificial pasture	Natural grassland	Roadside	Arable land	River side	Total
Northern Kyushu	10	2	6	0	5	23
Mid Kyushu	34	3	20	2	5	64
Southern Kyushu	15	0	12	3	1	31
Total	59	5	38	5	11	118

3. Collection and evaluation of ecotypes in perennial ryegrass

In Europe, perennial ryegrass is one of the important forage grasses producing high quality forage. But its petential is not yet evaluated in Japan, although it was introduced about a hundred years ago together with other forage grasses.

Its lack of persistency in Japan is mainly caused by heavy rainfall and high temperature in summer and heavy snowfall or low temperature in winter. Moreover, perennial ryegrass is overwhelmed in competition with other plant species when management of grassland is poor.

To develop new cultivars adapted to Japan, we have collected surviving clones since 1987, and evaluated their characteristics for breeding purpose. Outline of this research program is as follows.

1) Collection

Our collection program started from sending a questionnaire to national and prefectural agriculture or livestock experiment stations in Kanto and Tohoku district. The format of the questionnaire was as follows: Are there any grassland where perennial ryegrass survives over ten years? If so, will you answer the following questions.

① Number of years since the grassland established

② Location and altitude of the grassland

③ Density of perennial ryegrass

④ Suitable time for collecting seed

On the basis of the information, we selected one to seven sites from respective prefectures for collecting materials as shown in Fig. 1. Initially, we planned to collect materials as seed. But actually, seed-baring-panicles had been grazed or cut out, so we had to collect whole plants. The number of plants collected at one site was more than 20, and the total number collected in this program reached about 600 as shown in Table 9.

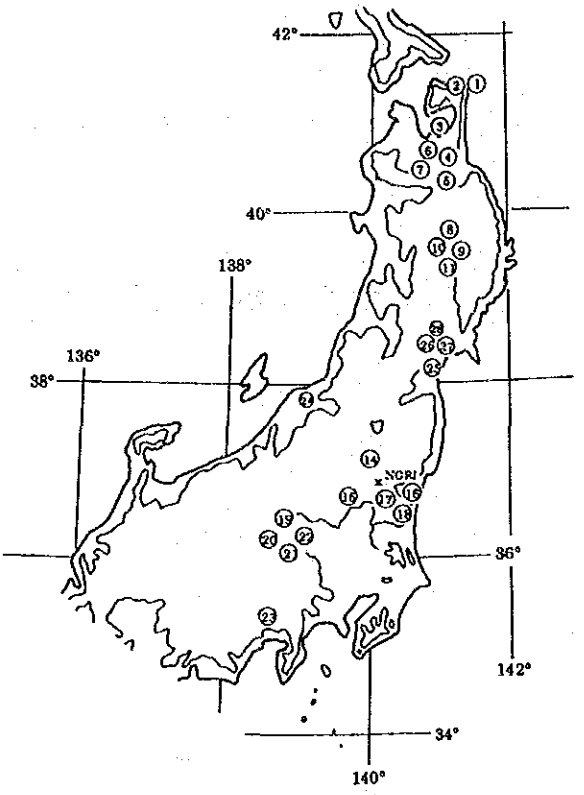

Fig. 1 Geographical distribution and collection sites of perennial ryegrass in 1987

2) Evaluation

Prior to evaluation, 18 plants were chosen at random from each of the original population collected at a site. Individuals multiplied from the original plant were planted at a space of 0.8m x 0.8m on an experimental farm with three replications (Photo 1).

For two years after planting, observation was continued for morphological characteristics, such as plant type, plant height, tiller number, panicle length, culm length, flag leaf length and width, and also for ecological characteristics, such as spring vigor, heading date, and disease resistance. Some accessions which were considered to be derivatives from tetraploid cultivars were examined for their ploidy by microscope.

Mean values and correlation coefficients between major characteristics were shown in Table 10 and 11, respectively. All the accessions were by and large classified into four groups on the basis of the data. Of them, the first group was

Table 9 List of perennial ryegrass collection sites in 1987-1988

No.	Prefecture	Location of collection site	Years after sawing	Altitude m	Sample type*
1	Aomori	Shiriya, Higashi-dori, Shimokita (Flat)	20	20	C
2	do	do (Hill top)	15<	50	C
3	do	Ishigami Bokujo, Hiranai	15<	60	C
4	do	Yokosawayama Bokujo, Tohoku	10<	85	C
5-1	do	Oou L.B.S., Shichinohe (Pasture 1)	10<	70	C
5-2	do	do (Paddok 2)	10<	70	C
6	do	Tahirotaira Bokujo, Aomori	10<	550	C, S
7	do	Yunotaira Bokujo, Towadako	10<	400	C
8-1	Iwate	Sodeyama, Kuzumaki (Cutting 1)	10<	1,000	C
8-2	do	do (Grazing 2)	10<	980	C
9	do	Hayasaka Bokujo, Iwaizumi	15<	900	C
10	do	Tohoku Agr.Exp.Stn., Morioka	15<	160	C
11	do	Sotoyama Branch, Tamayama	10<	700	C
12	Fukushima	Numajiri Branch, Inawashiro	15<	960	C
13	do	Bandaisan Bokujo, Inawashiro	10<	700	C
14	do	Shibahara Branch, Fukushima L.B.S., Shibahara	15<	800	C, S
15	Tochigi	Oozasa Ikusei Bokujo, Kuriyama	15<	900	C
16	Ibaraki	Satomi Bokujo, Kuji	15<	650	C
17	do	Mochikata Bokujo, Suifu, Kuji	15<	550	C
18	do	Oomiya Bokujo, Naka	10<	150	C
19-1	Nagano	Nat.G.R.I.,Alpine Region Branch, Miyota (1)	15<	1,250	C
19-2	do	do (2)	15<	1,150	C
20-1	do	Nagato Chouei Bokujo, Nagato (1)	10<	1,300	C
20-2	do	do (2)	10<	1,280	C
21-1	do	Uminokuchi Bokujo, Minamimaki (1)	15<	1,400	C
21-2	do	do (2)	15<	1,350	C
22	Gunma	Kouzu Bokujo, Shimonita	15<	1,000	C, S
23	Shizuoka	Shizuoka L.R.S., Fujinomiya	7<	650	C
24	Niigata	Itayama Shiei Bokujo, Shibata	15<	35	C
25	Miyagi	Shiraishi Bokujo, Shiraishi	10<	510	C
26	do	Kawasaki Bokujo, Shibata	15<	300	C
27	do	Daihachiyama, Sendai	10<	270	C
28	do	Kawatabi, Naruko	15<	530	C

* C : Clone, S : Seed.

Photo 1 Evaluation of ecotypes of perennial ryegrass

a large plant type estimated to be derivatives from tetraploid cultivars, and was characterized by late heading date, tall plant height, long panicle length and long leaf length. On the contrary, the forth group was distinguished by a small plant type with early heading date.

The large tetraploid group seemed to be most promising for its superiority in fresh weight and regrowth vigor after summer, though a precise evaluation is yet to be conducted on their persistency and productivity.

3) Multiplication and preservation

For preservation of these accessions as genetic resources, we kept the original plants at experiment farms continuously. Also, we preserved the seed which had been harvested in an isolation glasshouse. Because of the limitation of planting capacity in the isolation facility, to evaluate seed productivity we also preserved open-pollinated seed of each clone which was harvested at observation plots.

Table 10 Agronomic traits of perennial ryegrass clones in 1988

No.	Heading date from May 1	Plant type*	Panicle number**	Plant height (cm)	Panicle length (cm)	Culm length (cm)	Flag leaf length (cm)	Flag leaf width (mm)	Regrowth vigor*** at Sept. 6	Fresh weight at Oct.31 (g)
1	12.6	3.6	3.7	93.5	31.4	61.8	20.4	7.9	7.9	148
3	8.6	3.0	4.1	80.4	21.5	58.9	18.0	5.9	3.2	26
4	21.8	3.1	4.5	98.7	31.5	67.2	22.3	6.8	4.5	72
5-1	17.6	3.3	4.8	94.9	28.5	66.5	18.6	6.6	4.9	66
5-2	22.0	2.8	4.3	93.2	29.8	63.3	23.2	6.3	4.0	51
6	9.2	2.9	5.3	80.6	22.3	58.4	19.6	6.2	2.7	20
7	8.4	2.9	5.3	76.5	21.1	55.4	18.0	6.0	2.9	22
8-1	25.3	3.1	4.4	106.6	37.2	69.4	26.0	7.1	6.5	147
8-2	36.8	3.1	4.5	108.2	40.6	67.7	30.3	8.0	6.1	114
9	11.1	3.1	5.2	79.7	23.3	57.5	19.3	6.5	3.7	38
10	9.7	3.8	2.8	78.5	21.5	57.0	17.3	6.1	3.3	112
11	32.1	3.3	3.3	107.0	38.4	68.5	31.1	8.3	5.2	105
12	32.0	3.2	3.8	105.0	37.1	68.3	31.5	8.3	5.6	32
13	10.2	3.4	4.3	87.1	23.9	63.3	18.6	7.4	4.2	21
14	33.2	3.3	4.0	105.9	39.5	66.4	31.5	7.5	5.4	96
15-1	6.3	2.7	5.1	82.4	21.7	60.7	18.8	6.4	4.1	80
15-2	5.4	2.2	5.2	81.8	22.9	59.3	19.0	6.5	3.6	121
16	13.4	3.7	4.3	89.5	29.2	60.9	21.2	7.4	5.6	28
17	22.8	3.4	4.3	96.0	33.8	62.2	24.8	7.9	4.5	32
18	12.9	3.8	3.4	91.8	31.2	60.6	23.3	8.1	6.2	148
19-1	8.7	3.4	4.2	76.1	21.6	55.2	18.4	5.9	3.8	89
19-2	11.6	3.6	4.2	78.8	24.5	54.2	18.1	6.6	3.7	18
20-1	13.1	3.8	3.5	89.4	30.3	59.0	22.0	8.2	6.9	138
20-2	24.9	3.0	4.1	96.8	34.1	62.7	26.0	7.1	4.6	114
22	7.9	2.9	4.4	81.8	22.0	59.8	18.6	6.2	3.1	52
21-1	11.7	3.7	4.1	93.2	32.3	60.9	23.3	8.0	6.2	140
21-2	11.4	3.7	4.2	96.3	32.0	64.4	22.5	8.3	6.9	24
23	12.6	4.5	2.2	85.8	30.7	55.1	19.9	8.1	5.8	93

* : 1 (erect) ~ 5 (prostrate), ** : 1 (few) ~ 9 (abundant), *** : 1 (poor) ~ 9 (vigorous).

Table 11 Correlation coefficients between major agronomic traits in 1988

	Plant type	Panicle number	Plant height	Panicle length	Culm length	Flag leaf length	Flag leaf width	Regrowth vigor	Fresh weight
Heading date	–0.023	–0.184	0.893**	0.888**	0.776**	0.933**	0.485**	0.366	0.547**
Plant type		–0.777**	0.058	0.023	–0.193	–0.005	0.541**	0.524**	0.461*
Panicle number			–0.202	–0.334	0.032	–0.213	–0.501**	–0.435*	–0.439*
Plant height				0.958**	0.914**	0.904**	0.680**	0.643**	0.768**
Panicle length					0.760**	0.924**	0.771**	0.710**	0.832**
Culm length						0.753**	0.452*	0.450*	0.563**
Flag leaf length							0.645**	0.479**	0.671**
Flag leaf width								0.835**	0.870**
Regrowth vigor									0.941**
Fresh weight									

4) Utilization of ecotypes

After evaluation of morphological and ecological characteristics for the collected ecotypes, any clones and lines with some particular characteristics were sent to breeding stations, and their agronomic characteristics such as persistency and productivity were precisely evaluated for breeding. As a matter of cause, ecotypes collected from Hokkaido showed good adaptability in persistency and productivity in Hokkaido, and those from Kanto did so in Kanto.

4. Collection and evaluation of ecotypes of wild species in Japan

Among wild plant species utilized for feeding livestock in Japan, the following were objective species in this exploration and collection program; Japanese lawngrass (*Zoysia japonica* STEUD.), needlegrass (*Imperata cylindrica*) from indigenous species and fall panicum (*Panicum dichotomiflorum* MICHX), rescuegrass (*Bromus catharticus* VAHL.) from naturalized species and others (seven species from Gramineae in total), and common lespedeza (*Lespedeza striata*), sericea lespedeza (*Lespedeza cuneata* G. DON.), birdsfoot trefoil (*Lotus corniculatus* L. var. *japonicus* REGEL.), and others (indigenous four species from Leguminosae in total).

Outlines of this program for Japanese lawngrass, fall panicum, and birdsfoot trefoil were summarized as follows.

1) Japanese lawngrass (*Zoysia japonica* STEUD.)

Japanese lawngrass distributes mainly in Japan, Korea, and Taiwan, and inhabits from sea level up to mountainous area of 1,500m in altitude. Collection sites and main characteristics of accessions were shown in Fig. 2, and in Table 12 and Table 13.

Morphological and ecological characteristics, such as dry weight production, growth ability of runner, leaf length, number of heading panicles, and 1,000 grains weight, indicated big differences among ecotypes which were collected throughout Japan from Kyushu to southern Hokkaido.

Japanese lawngrass is generally propagated vegetatively by transplanting of stolon or setting of grass mat, but can also be seed- propagated.

Table 12 Agronomic traits of 20 lines of Japanese lawngrass (*Zoysia japonica*)

No.	Collection site (altitude, m)		Dry weight g 1981	Dry weight g 1982	Growth length cm 1981	Growth length cm 1982	Leaf length* at Aug.31 mm	Leaf width* at Aug.31 mm	Heading panicle number per m²*	1000 grain weight* g
1	Nagasakibana	10	19.4	30.8	391.0	139.6	121.1	4.69	811	0.662
2	Kujuu	480	4.0	24.2	72.3	127.6	143.7	5.34	378	0.685
3	Ooita L.R.S.	650	17.1	55.8	280.5	196.9	206.4	5.84	778	1.097
4	Zentuji	200	15.7	19.3	425.4	114.7	111.8	4.35	356	0.786
5	Yawatabara	800	24.1	63.2	496.5	277.3	179.5	5.02	644	0.867
6	Dogosan	1,200	19.9	19.1	550.5	113.7	145.2	4.49	456	0.649
7	Chiburi	300	23.9	43.6	682.3	290.1	161.7	4.69	811	0.828
8	Akahageyama	320	13.2		424.3		129.1	5.33	522	0.704
9	Sugadaira	1,400	25.0	58.3	506.6	314.1	206.8	5.30	967	1.030
10	Mesimoriyama	1,600	25.6	67.8	519.0	372.6	193.1	5.62	889	1.056
11	Yatsugatake	1,340	31.0	75.5	1,006.8	577.0	265.8	5.08	100	0.936
12	Oonoyama	700	38.8	59.6	902.8	293.2	342.0	5.08	378	0.763
13	Tashirodaira	600	30.0	70.4	755.8	416.7	135.0	4.61	1,900	0.887
14	Fujinita	310	28.2	82.4	966.4	631.2	170.3	5.16	667	0.918
15	Kozato	600	40.2	59.8	1,154.8	388.7	158.6	4.72	1,111	0.884
16	Kousha	1,000	29.0	83.2	777.0	469.2	171.4	4.98	1,111	1.910
17	Sodeyama	1,000	15.2	34.5	528.4	231.6	160.5	5.08	1,444	1.071
18	Suttu	10	17.9	56.4	665.6	457.8	174.3	5.15	822	1.101
19	Hyakuninhama	10	26.8	86.0	697.4	465.6	140.2	4.60	2,100	1.093
20	Oozasa	900	41.8	59.2	834.0	324.5				

*: Observed in 1983.

Table 13 **Cold resistance of Japanese lawngrass given by index of covering area**

No.	Collection site	Temperature treated				
		−12.5	−15.0	−17.5	−20.0	−22.5°C
1	Nagasakibana	64	33	9	0	0
2	Kujuu	85	85	21	1	0
4	Zentuji	100	99	58	18	0
5	Yawatabara	91	88	33	6	0
8	Akahageyama	74	78	22	1	0
9	Sugadaira	89	91	77	17	0
11	Yatugatake	100	74	84	58	0
12	Oonoyama	93	92	63	30	1
13	Tashirodaira	91	83	60	17	0
14	Fujinita	100	90	63	50	0
17	Sodeyama	88	91	65	5	0
21	Nangoku	90	90	67	17	0

Observed in July, 1984.

Accessions from high-altitude sites indicated a tendency of higher seed production ability than accessions from low altitude sites. The seed production ability is an important characteristics for seed propagation system. This tendency is dependent more or less on the number of heading panicles as shown in Table 14. Moreover, big differences among accessions were also observed on seed fertility, seed dormancy, and germinability.

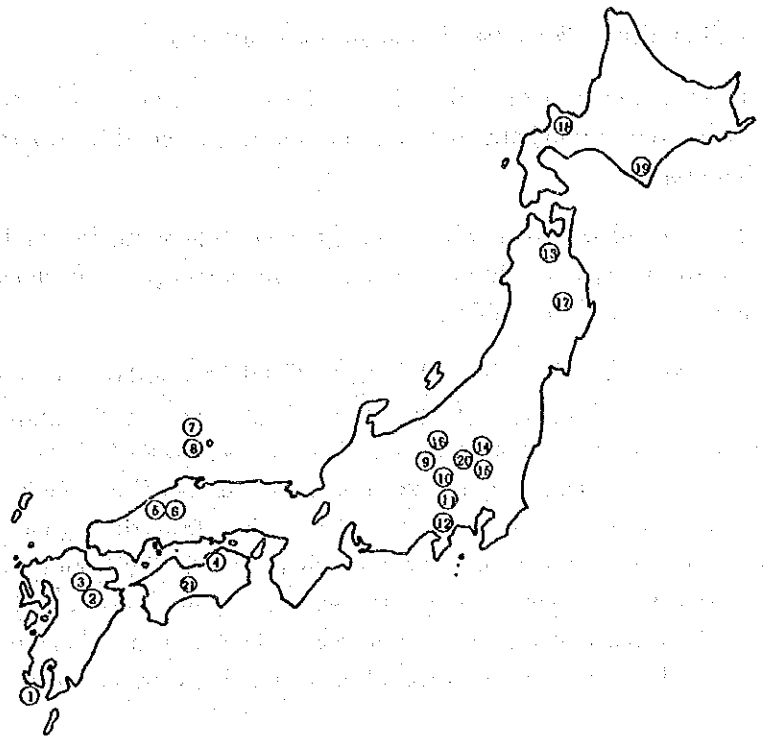

Fig. 2 Collection sites of Japanese lawngrass (*Zoysia japonica*)

Table 14 Seed yield of Japanese lawngrass

Collected region	Number of ear*	Seed weight* g	Number of strain examined
Hokkaido	1,018	24.8	6
Tohoku	325	7.4	7
Kanto	180	4.7	3
Tosan	97	2.5	2
Tokai	48	0.9	4
Hokuriku	50	1.8	1
Chugoku	25	0.6	2
Shikoku	57	1.1	6
Kyushu	18	0.4	5

*: Harvested from 10 individuals.

2) Fall panicum (*Panicum dichotomiflorum* MICHX.)

Fall panicum is an annual wild grass and a newly naturalized one in Japan. It was observed throughout Japan when we conducted this exploration and collection program.

Numbers of accessions which were grouped by heading date and stem type were indicated on each collection site in Fig. 3, and major agronomic characteristics were shown in Fig. 4 and Table 15.

Accessions from Kyushu and Chugoku district showed wide variation which included early heading type, medium heading type, late heading type, and fine stem type. Whereas, all of accessions from the region eastwards from Chubu district were early heading type, except one medium heading type from Mouka, Tochigi Prefecture, though the number of accessions from this region was small. Accessions of very early heading type which were collected from Hokkaido and Niigata Prefecture were photo-insensitive with fine stems, and quite different from others in their morphological characteristics . The very early heading type was considered to be unsuitable for practical cultivation because of its low forage yield.

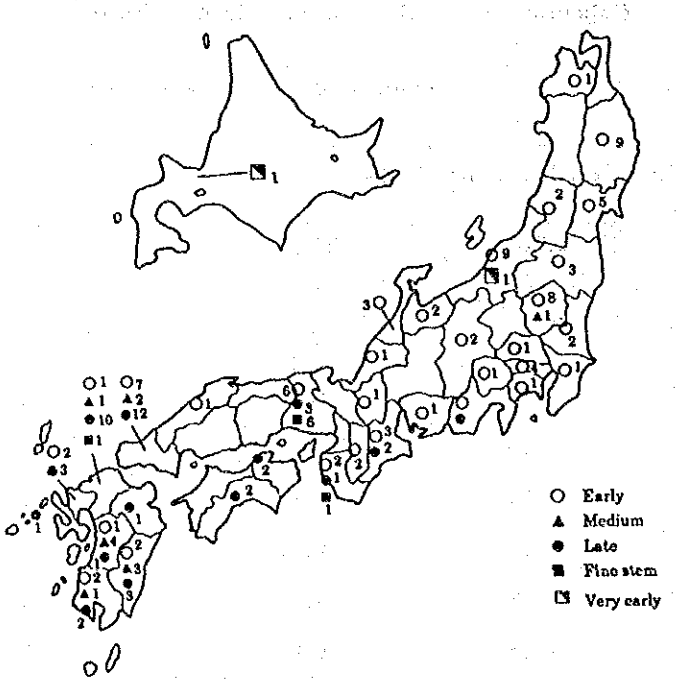

Fig. 3 Collection sites and number of accessions of fall panicum (1987)

Table 15 Agronomic traits at harvest time of five groups of fall panicum

Plant type group	Collection site	Heading date	Observation date	Main culm						Whole plant		
				Survival leaf number	Dryed leaf number	Leaf length cm	Leaf width cm	Culm length cm	Ear length cm	Fresh weight g	Culm number	Ear number
Early	Kokubu B	July 15	Aug. 6	7.0	0	55	2.3	117	35	584	22	17
	Chiba	July 16	Aug. 6	6.4	0.3	51	2.1	105	34	362	18	14
	Etsuko	July 16	Aug. 6	5.8	0.4	51	2.1	122	34	608	21	17
Fine stem	Tokusa	July 13	Aug. 5	7.0	0.3	45	2.2	99	25	619	24	17
	Fujino 2	July 13	Aug. 5	4.5	0.1	44	2.1	80	28	336	27	21
	Tsukusino	July 18	Aug.12	4.9	0	58	1.4	86	45	445	27	18
Medium	Mouka	Aug. 25	Sep.13	4.4	6.0	60	2.1	131	47	625	14	13
	Mukaie	Aug. 25	Sep.13	6.3	6.4	59	2.1	187	31	792	15	10
	Chousa	Aug. 25	Sep.13	4.4	5.1	61	2.6	154	43	628	12	9
Late	Fujino 1	Sep. 13	Oct. 5	7.1	10.3	43	2.2	233	32	1,619	13	9
	Mure	Sep. 24	Oct. 4	7.7	8.7	51	2.4	235	36	1,314	14	10
	Mochitomegawa	Sep. 25	Oct. 4	8.0	10.0	48	2.3	246	33	1,439	18	16
	Kokubu C	Sep. 26	Oct. 4	8.0	10.5	48	2.5	241	30	1,393	20	14
	Ooita	Sep. 27	Oct. 4	6.1	12.5	44	2.4	250	33	1,252	19	16
	Imafuku	Sep. 28	Oct. 4	6.1	8.4	45	2.1	221	33	1,336	15	11
	Mitajiri	Oct. 1	Oct. 6	7.2	8.9	57	2.4	227	35	1,631	22	18
Very late	Hirutsubashi	Oct. 6	Oct. 6	5.2	12.2	53	2.6	266	32	562	9	4
	Oono B	Oct. 10	Oct.10	6.3	11.4	38	2.2	211	23	843	15	13

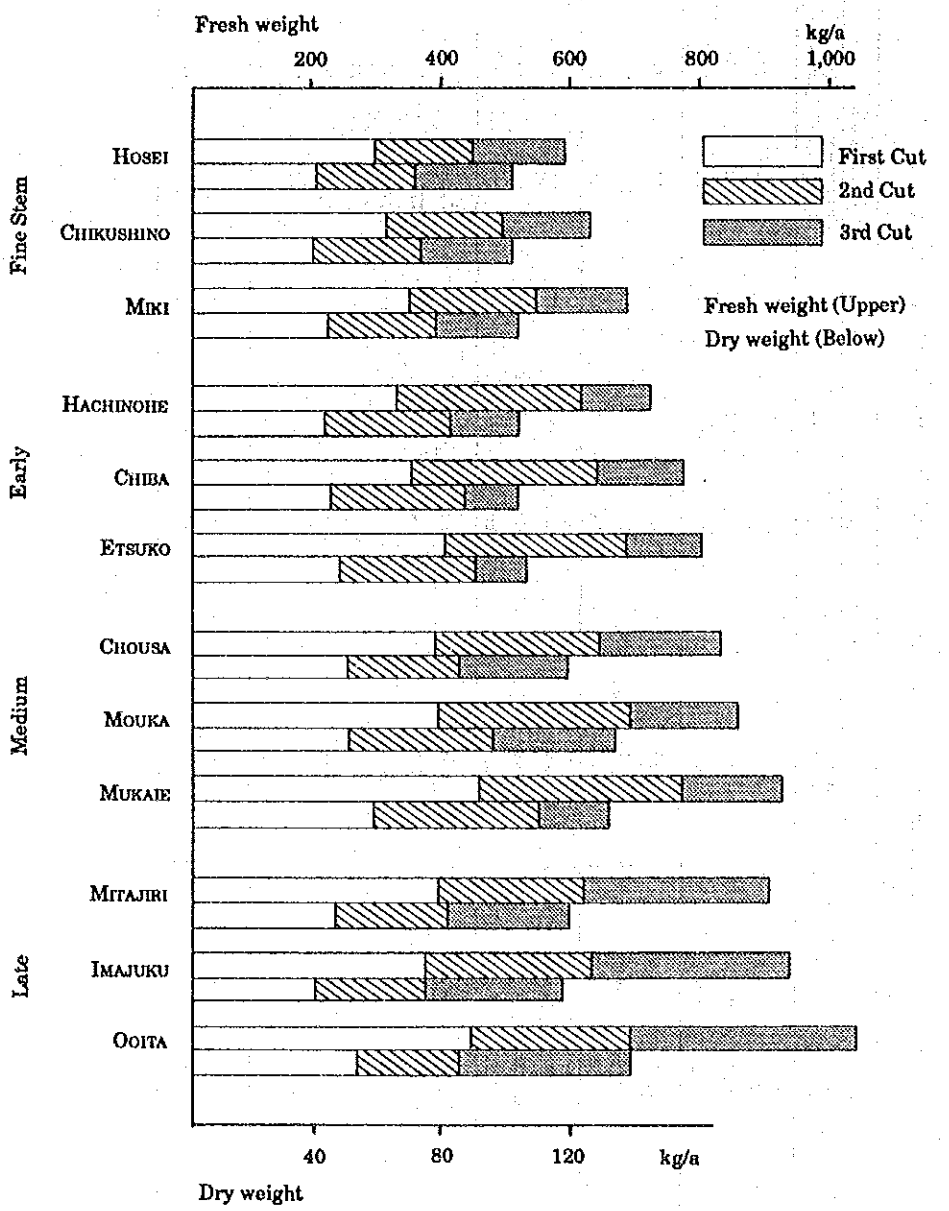

Fig. 4 Yielding ability of four groups of fall panicum

Fall panicum is high yielding with its tolerance to high temperature condition. Especially, some accessions belonging to medium and late heading types were considered to be suitable for direct use as a forage crop. Among them, Oita line is being cultivated as a forage crop by dairy farmers in warm regions, but shattering of matured seed and low seed yield are problems for the cultivation like as other tropical panicum species.

3) Birdsfoot trefoil (*Lotus corniculatus* L. var. *japonicus* REGEL.)

Birdsfoot trefoil is an indigenous wild legume with yellow flower, and may be introduced into a short-stature grassland in mixture with grass species. Wild birdsfoot trefoil is a diploid species with the chromosome number of 2n=12, while improved cultivars of birdsfoot trefoil are tetraploid species with the chromosome number of 2n=24 (Photo 2 and 3).

Accessions were classified into six groups; i.e. Hokkaido, Tohoku, Kanto-Koshin, Hokuriku, Tokai-Chugoku-Shikoku, and Kyushu group. Observation criteria for 17 major agronomic characteristics and the observed data of six groups were shown in Table 16 and 17, respectively.

Distinctive features of each group were as follows.

Accessions from Tokai-Chugoku-Shikoku group were high in plant height from seedling stage to harvesting time, early in flowering and maturing time, light in leaf and stem color, and high in seed yield and survival rate.

Accessions from Kyushu group were short in plant height, late in flowering and maturing time, and low in seed yield and survival rate. Those from Hokkaido group were dark in leaf and stem color, and late in flowering and maturing time, and those from Hokuriku group were high in seed yield and survival rate.

As collection sites ranged from Northern latitude of 32° in Kyushu to 44° in Hokkaido and from an altitude of 2m in a coast to an altitude of 1,850m in mountainous areas, correlation coefficients between major agronomic characteristics and geographical figures of collection sites were calculated, and were shown in Table 18.

Photo 2 Birdsfoot trefoil flowering in a wasteland

Photo 3 Birdsfoot trefoil flowering at a slope of a bank

Table 16 Dates and observation criteria of 17 agronomic characteristics in birdsfoot trefoil (SUGINOBU *et al.* 1988)

Characteristics	Observation criteria	Note
Plant height (J)	Measured in cm	March 18, 1982
Stem number (J)	Counting	March 18, 1982
Leaf color (J)	1=light green ~ 5=dark green	March 18, 1982
Stem color (J)	1=light green ~ 5=purple	March 18, 1982
Plant type	1=prostrate ~ 9=upright	June 25, 1982
Plant height	Measured in cm	June 22, 1982
Stem number	1=few ~ 9=many	June 28, 1982
Stem color	1=light green ~ 9=purple	June 28, 1982
Stem size	1=thin ~ 9=thick	June 28, 1982
Plant weight	Naturally dried in glasshouse and measured in g	Optimum time for each plant
Flowering time	1=April 1 ~ 120=July 29	Date at three florets opened
Harvesting time	1=April 1 ~ 142=August 20	Optimum time for seed yield
Maturing days	Harvest time ~ Flw. time	For each plant
Seed yield	Measured in g	For each plant
Regrowth	1=poor ~ 9=vigorous	September 29, 1982
Fall vigor	1=poor ~ 9=vigorous	November 30, 1982
Surviving plt.	Surviving plant ration in %	May 3, 1983

(J): Characteristics in juvenile stage.

Table 17 Means of agronomic traits of strains collected from 6 different regions in birdsfoot trefoil (SUGINOBU *et al.* 1988)

Region	Plt.ht.(J)	Stem no.(J)	Leaf col.(J)	Stem col (J)	Plt.type	Plt.ht.	Stem no.	Stem col.	Stem size
Hokkaido	7.5±1.07	27.6±5.38	4.74±0.14	4.33±0.20	2.68±0.18	39.7±3.85	5.21±0.28	8.23±0.31	4.78±0.11
Tohoku	8.1±1.52	31.2±6.96	4.03±0.49	4.04±0.36	2.93±0.10	32.6±4.18	4.37±0.46	8.09±0.49	4.50±0.28
Kanto, Koshin	9.6±1.79	27.7±3.15	3.72±0.43	3.92±0.34	2.76±0.14	36.2±4.08	5.02±0.49	7.92±0.39	4.33±0.22
Hokuriku	10.5±1.69	32.3±3.22	3.83±0.42	3.64±0.40	2.78±0.23	44.1±3.26	6.08±0.37	7.47±0.61	4.90±0.13
Tokai, Chugoku, Shikoku	20.1±4.46	33.4±9.95	2.64±0.43	2.59±0.29	2.73±0.28	46.8±4.78	5.60±0.29	5.46±0.64	4.78±0.29
Kyushu	4.4±1.03	24.5±5.85	3.75±0.35	3.42±0.31	2.49±0.21	27.9±3.75	4.16±0.58	7.85±0.43	4.30±0.30
Mean	9.6±1.26	29.3±2.04	3.85±0.20	3.72±0.17	2.73±0.07	37.9±2.07	5.10±0.22	7.60±0.27	4.60±0.10

Region	Plt.wt. g/plt.	Flow.time	Harv.time	Matur.days	Seed yield g/plt	Regrowth	Fall vigor	Surv.plt. %
Hokkaido	76.9± 9.27	67.7±5.65	112.7±3.98	44.9±2.04	4.35±1.64	1.08±0.36	1.11±0.42	36.9± 9.89
Tohoku	41.2± 9.80	59.5±5.41	107.5±6.13	48.1±4.21	2.00±1.38	0.53±0.46	0.60±0.59	21.7±20.38
Kanto, Koshin	42.6±12.68	58.9±6.28	105.8±3.14	47.3±3.64	2.45±1.44	0.42±0.18	0.45±0.20	23.6±10.51
Hokuriku	76.0±15.58	58.3±3.06	104.6±2.10	46.4±1.79	5.49±1.56	1.24±0.48	1.53±0.68	46.1±14.38
Tokai, Chugoku, Shikoku	58.3±10.62	40.2±4.74	93.7±3.95	53.5±3.95	5.91±1.96	2.21±0.79	2.88±1.15	78.9±12.96
Kyushu	28.4±10.58	66.7±3.14	107.9±3.07	41.2±1.06	1.68±1.01	0.36±0.13	0.22±0.13	12.7± 7.65
Mean	54.9± 6.32	59.4±2.68	105.9±1.86	46.6±1.32	3.63±0.67	0.92±0.21	1.07±0.28	35.2± 6.74

Means are indicated with standard error at the 5% level.

Table 18 Correlation coefficients between locational factors and 17 agronomic traits in birdsfoot trefoil (SUGINOBU *et al.* 1988)

Characteristics	Latitude	Altitude
Plant height (J)	−0.09	−0.33**
Stem number (J)	0.05	−0.31*
Leaf color (J)	0.52**	0.02
Stem color(J)	0.57**	0.05
Plant type	0.13	−0.05
Plant height	0.21	−0.49**
Stem number	0.17	−0.22
Stem color	0.35**	0.24
Stem size	0.26*	−0.50**
Plant weight	0.47**	−0.49**
Flowering time	0.24	0.36**
Harvesting time	0.36**	0.30*
Maturing days	0.01	−0.29*
Seed yield	0.17	−0.55**
Regrowth	0.04	−0.25*
Fall vigor	0.02	−0.28*
Surviving plant	0.04	−0.21

Significant correlation coefficients with plus sign were found between latitude and some characteristics; i.e. leaf color, stem color, stem size, plant weight, and harvesting time. It was also found between altitude and flowering- or harvesting-time. Whereas, significant correlation coefficients with minus sign were found between altitude and some characteristics; i.e. plant height, stem number, stem size, plant weight, maturing date, seed yield, regrowth vigor, and fall vigor.

5. Conclusion

There are many plant species utilized for feeding livestock as forage crops or wild grasses and legumes. They are in use in various types, such as grazing, hay or silage.

Recently, in the shortage of farm labors some of natural grasslands in Japan, which have been exploited for the past several hundred years, are becoming waste lands. Indigenous wild species which adapted to the natural grasslands are endangered in the succession from grasses to trees.

At present, renovation of pastures is widely practiced to improve their productivity by introduction of new high yielding cultivars. Old pastures in which we can find valuable survivals of important plant species for genetic resources are being exploited. Therefore, collection and preservation of these materials are very much important for forage crop breeding, like as an introduction of new genetic resources from abroad.

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Description of Plant Genetic Resources and a Computer Management System

by

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CONTENTS

1. Introduction

Exploration and collection of plant genetic resources have been systematized, while large collections become preserved in gene banks at various places in the world. In Japan, the Gene Bank (GB) of the Ministry of Agriculture, Forestry and Fisheries (MAFF) preserves more than 60,000 accessions which are ready for distribution, and is to preserve more than 100,000 accessions in the near future. The more accessions are preserved in GB, the more accurate management is required for plant genetic resources. In particular, detailed information is necessary to choose desired materials out of numerous accessions which may meet users' needs.

Information necessary to manage genetic resources at GB can be divided into three categories. The first is passport data including varietal name, history and others. Passport data are the most basic information on genetic resources, and should be completed as fast as possible after each collection of genetic resources. The second is data of items to be evaluated or characterized, e.g., morphological or agronomic traits, and is important for efficient use of preserved genetic resources by researchers and plant breeders. The third is management data indicating amount of seeds, germinability and location in storage facilities. Such data are necessary to maintain sufficient reserves of genetic resources.

GB of MAFF has recently completed the passport data for plant genetic resources preserved at its research stations and institutes, and has begun to compile evaluation data on each accession.

A standard list of characters to be described, i.e., 'descriptors' adapted to computerized management of plant genetic resources has been established since July in 1990 in order to fast build up the database of evaluated agronomic traits for genetic resources at MAFF. Because the proposed descriptor system has to manage a huge number of data for more than 100 plant species, description forms of evaluation data are carefully designed so that the data are efficiently controlled by a computer system. So far, the proposed descriptor system is working well, which is introduced below.

2. Guidelines for testing of distinctiveness, uniformity, stability and evaluation criteria of agronomic traits for genetic resources management in the MAFF GB

In the registration of more than 100 plant species in compliance to the Seed and Seedling Law, MAFF guidelines for testing of distinctiveness,uniformity and stability have been established for each plant species. The guidelines which include kind of traits, number of objective items,evaluation methods, classification system, and measuring unit etc. are formulated to meet the criteria of International Union for the Protection of New Varieties of Plants (UPOV).

Evaluation of genetic resources preserved by MAFF is conducted by plant breeders at respective breeding centers which serves as sub-banks of GB of MAFF. The MAFF guidelines for varietal registration are referred to by them both for their breeding materials and plant genetic resources.

One of the problems for plant breeders is that emphases of MAFF guidelines for varietal registration are placed mainly on stable traits for discriminating varietal differences. To apply the evaluation criteria to evaluation of genetic resources, emphases should be placed on the traits which were efficiently used to differentiate genetic resources from each other. Objective items for evaluation are separated into mandatory items and optional ones. As it is difficult to evaluate all items of numerous genetic resources at one time, traits for evaluation were classified into three categories as follows.

(1) *Traits necessary to differentiate accessions : the primary traits*

The primary traits are utilized to differentiate accessions from each other, most of which are morphological characteristics important for distinguishing different accessions at the time of reproduction.

(2) Traits important for utilization of genetic resources, such as disease resistance, insect resistance, tolerance to other stresses, and etc.: the secondary traits

The secondary traits include those important for selecting breeding materials, though special facilities or special environmental conditions are needed to evaluate them.

(3) Traits relating to yielding ability and quality etc.: the tertiary traits

The tertiary traits are variable with changes of environmental conditions, and it is rather difficult to evaluate them.

Items in the three categories of trait are further divided into those for mandatory evaluation and for optional. Therefore, items aredivided into six categories. Table 1 shows an example for rice (*Oryza sativa*). Selection and classification of these items are conducted by researchers responsible for each plant species.

3. Items of traits and an organization for evaluation of rice genetic resources, an example

In case of mandatory or essential items in rice, there are 13 primary traits including culm length and panicle length etc., twelve secondary traits including estimated genotypes for blast resistance and field resistance to leaf blast etc., and eight tertiary traits including yield and 1,000 husked grain weight. Besides above mentioned mandatory items,some are added as optional ones. Evaluation criteria for each item include number of samples, evaluation methods, classification system and measuring unit etc..

To meet evaluation of genetic resources, emphases of evaluation criteria are placed on the following three points:

(1) Evaluation data of some traits such as culm length and panicle length are indicated by observed values itself instead of graded classes, because variation of these traits within world collections were expected to be wider than those within Japanese cultivars.

(2) Evaluation methods and sampling numbers are somewhat simplified.

(3) Resistance is classified into only three grades, namely highly resistant (RR), medium (MR) and highly susceptible (SS) to distinguish varietal differences.

Thirteen rice breeding centers have conducted evaluation tests of rice genetic resources in Japan. For evaluating the primary traits, Hokkaido Agricultural Experiment Station (AES) is responsible for extra early maturing accessions, Okinawa Branch of Tropical Agricultural Research Center (TARC) is responsible for extra late maturing accessions, and Hokuriku AES is responsible for medium maturing accessions, and National Agriculture Research Center (NARC) in Tsukuba is responsible for wild species of rice.

For evaluating the primary traits, Hokkaido AES is responsible for cold tolerance, NARC in Tsukuba is responsible for resistance to stripe disease, and

Table 1 MAFF's classification of evaluation items for plant genetic resources

Primary traits	Secondary traits	Tertiary traits
Traits for characterization of each accession, mainly morphological characteristics	Resistance to diseases and insects, drought tolerance and growth habit	Yielding ability, quality and chemical composition
	(Mandatory items for rice)	
① Culm length	① Estimated genotype for blast resistance	① Yielding ability
② Panicle length	② Field resistance to leaf blast	② Thousand kernel weight
③ Panicle number	③ Resistance to stripe disease	③ Shattering
④ Apiculus color	④ Resistance to green leafhopper	④ Quality of hulled rice
⑤ Grain length	⑤ Resistance to brown plant hopper	⑤ White belly rice
⑥ Grain width	⑥ Drought tolerance	⑥ Edible quality
⑦ Glutinous/nonglutinous	⑦ Cold hardiness	etc.
⑧ Heading time	⑧ Lodging resistance	
⑨ Lemma and palea color	etc.	
⑩ Awn length		
etc.		

Kyushu AES is responsible for resistance to bacterial leaf blight and brown planthopper. With regard to resistance to leaf blast, several regional AESs share evaluation tests with respective races of blast fungus.

The tertiary traits are evaluated by six regional AESs which are responsible for six regions in Japan: Hokkaido, Tohoku, Hokuriku, Kanto, Chugoku and Kyushu. When new accessions are available, GB of MAFF starts to evaluate their primary traits first, then secondary traits followed by tertiary traits. The GB of MAFF is planning to increase evaluation items relating resistance to diseases and insect pests, chemical components, and quality traits which will be important in future.

International Rice Research Institute (IRRI) has developed the minimum descriptors adapted to a computer system for rice genetic resources incooperation with International Board for Plant Genetic Resources (IBPGR). The contrast between IRRI's minimum descriptors and the system proposed by us is shown in Table 2. Construction of an interchangeable system between the two systems is expected for efficient use of plant genetic resources in international cooperation.

4. Some details in the development of database at MAFF GB

Information which defines items of traits and description manner for each crop is provided by item definition data. The item definition data will reach a huge number when a large number of plant genetic resources are evaluated for many traits. The proposed guideline is transitional, and not yet completed for all crop species. Therefore, the guideline may be modified in the process of evaluation tests in future. It will not be necessary here to show every details of the guidelines, when modification or addition of the guideline is still planned. We are planning to develop a new system, in which all the item definition data are stored in the database and can be taken out of it whenever necessary. The function of the proposed guideline is expected both in recording and storing of item definition data and in other objectives, e.g., in constructing of application program for data management or printing.

1) Database for genetic resources management

We are developing the database for genetic resources management since 1987. The passport data management system and the stock management system have been developed, and the item evaluation data management system is on the

Table 2 A comparison of descriptor-states between MAFF's and IRRI/IBPGR's descriptors for characterizing rice cultivars

Descriptor	MAFF	IRRI/IBPGR
(Leaf)		
Blade pubescence	0:glabrous ~ 9:pubescent	0:glabrous ~ 9:pubescent*
Blade color	1:yellow ~ 8:purple, 9:others	1:pale green ~ 7:purple*
Leaf sheath color	1:yellow ~ 8:purple, 9:others	1:green ~ 4:purple*
Flag leaf angle	2:erect ~ 8:descending	1:erect ~ 7:descending*
(Culm)		
Culm length	length (cm)	length (cm)
Culm number	-----	number/plant
Plant type	2:panicle weight type ~ 8:panicle number type	1:erect ~ 9:procumbent*
(Panicle)		
Panicle length	length (cm)	length (cm)
Panicle number	number/plant	---
Panicle type	1:*lanceolate* ~ 9:*open*	1:compact ~ 9:open*
Shattering	2:very low ~ 8:very high	1:very low(<1%) ~ 9:high(>50%)
(Grain)		
Awning	0:absent ~ 9:fully awned	0:absent ~ 9:long and fully awned
Awn length	2:very short ~ 8:very long	
Awn color	1:pale yellow ~ 9:dark purple	1:straw ~ 6:black*
Apiculus color	1:pale yellow ~ 9:dark purple	1:white ~ 7:purple apex*
Lemma and palea color	1:pale yellow ~ 8:dark purple, 9:others	0:straw ~ 9:black*
Length of unhulled rice	length (mm)	length (mm)
Width of unhulled rice	width (mm)	width (mm)
Kernel weight	1000-grain weight (g)	100-grain weight
Glutinous/nonglutinous	2:nonwaxy, 8:waxy	1:nonwaxy, 2:waxy, 3:indeterminate*
(Growth)		
Heading time	50% heading date	number of days from effective seeding date to 50% heading
Maturing time	the date when most of the grains on the panicles are fully ripened	number of days from seeding to the time when more than 80% of the grains on the panicles are fully ripened

* Use X for a mixture of different types

way to completions. Then, a total management for genetic resources will be realized by the three management systems (Fig. 1).

The present system is constructed by using relational database of UNIX, multi-user and multi-task OS, and has a function which can perform the passport data management in parallel with the stock management simultaneously for a lot of genetic resources. As the first step to improve the item evaluation data management system, a system of item evaluation manual has been proposed.

2) Management program for item definition data

The frame and sections data management program has been developed by using informix-4GL as a description language. This program has various functions of input, modification, deletion, and rearrangement of each item definition datum, and is handled on a terminal display.

To prevent distinguishable mistakes, input data are immediately processed by a data-check system, and coded data indicate their actual meaning. Therefore, data input is possible even by operators without special training. For example, an input of a huge number of item definition data of ca. 5,000 items or ca. 600 printed pages, which were provided by a curator, were processed by 4 operators in about one month. This program is developed by SHOU and UMEHARA.

3) Application system for item definition data

Input data in the database for item definition can be utilized for various objects. Some examples of application programs which have been developed are as follows:

(1) Printing program for guidelines

In order to manage many kinds of item definition data dynamically, this printing program is described in C language. Fig. 2 shows the guideline which is off-printed by this program. This program is developed by TAKEDA.

(2) Printing program for description forms for evaluation data

Description forms for data by the guideline is printed by this program which is described in C language. This program is developed by SHOU.

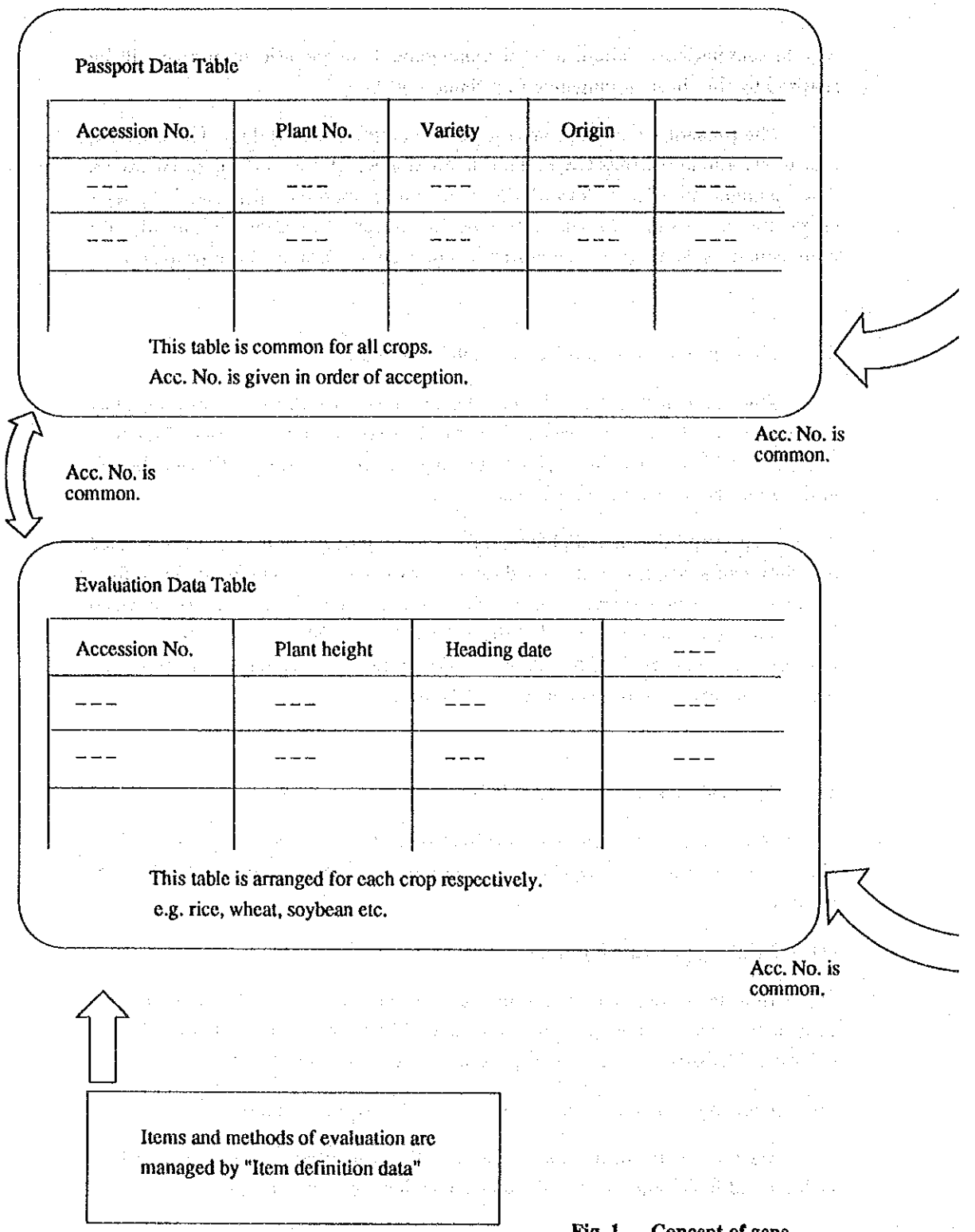
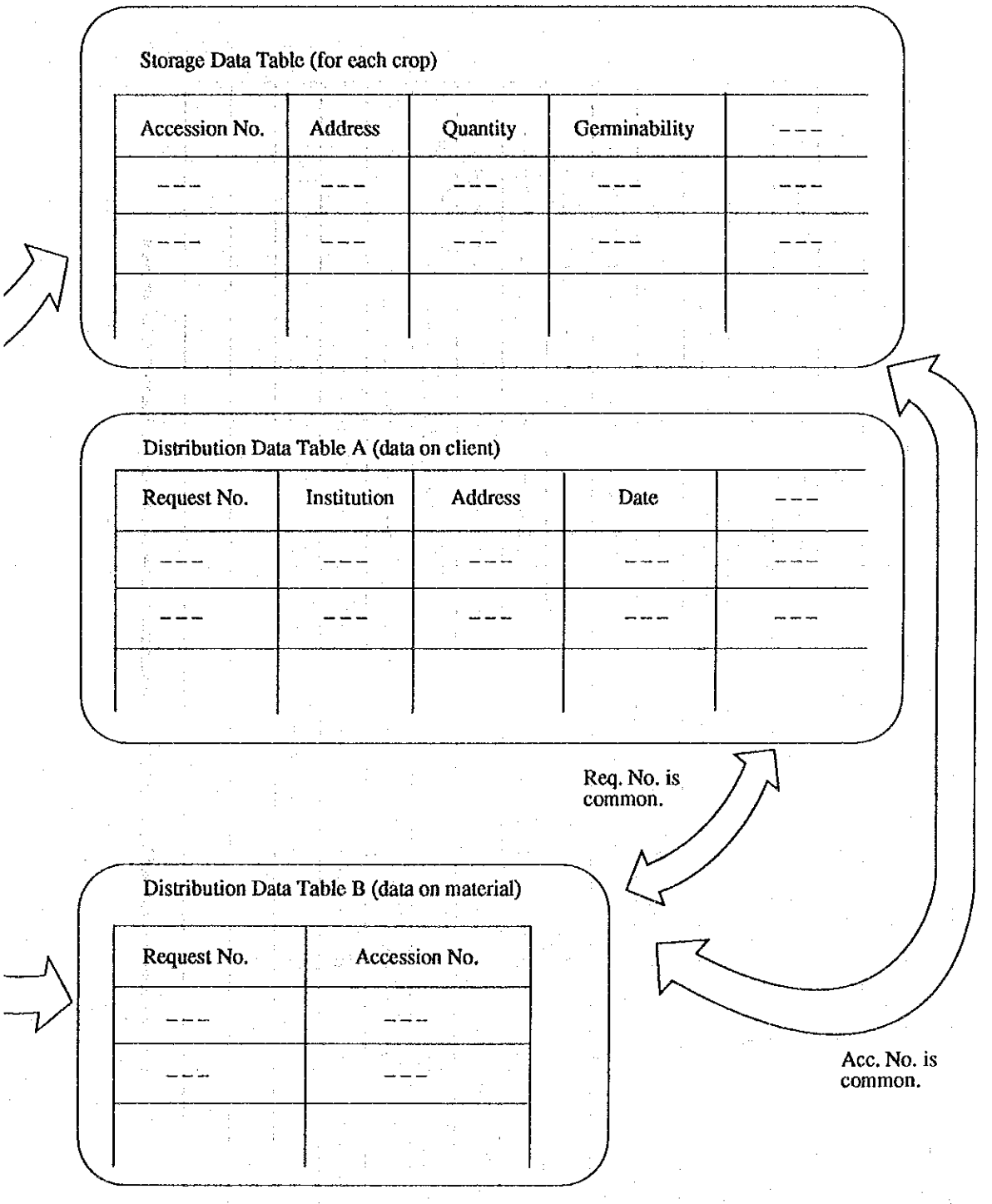


Fig. 1 Concept of gene



bank database system

作物の種類	稲			01001	1次必須項目										
項目番号	項目名	調査数	方法	分級・単位 0	1	2	3	4	5	6	7	8	9	調査方法等
1	稈長	5個体	測定	cm（小数第1位を四捨五入）										生育が中庸の個体の最長稈の地際から穂首までの長さ
2	穂長	5個体	測定	cm（小数第2位を四捨五入）										生育が中庸の個体の最長稈の穂首から穂の先端（芒を除く）までの長さ
3	穂数	5個体	測定	本/個体（小数第2位を四捨五入）										遅れ穂を除く穂の数
4	ふ先色	区	観察		黄白～黄	黄褐	褐	赤褐	淡赤	赤	淡紫	紫	黒紫	成熟期（出穂後3週間目）におけるふ先の色
5	籾長	5粒	測定	mm（小数第2位を四捨五入）										投影機又はダイアルゲージ等により測定した籾の長さ
6	籾幅	5粒	測定	mm（小数第2位を四捨五入）										投影機又はダイアルゲージ等により測定した籾の幅
7	玄米長	5粒	測定	mm（小数第2位を四捨五入）										投影機又はダイアルゲージ等により測定した玄米の長さ
8	玄米幅	5粒	測定	mm（小数第2位を四捨五入）										投影機又はダイアルゲージ等により測定した玄米の幅
9	うるち（粳）・もち（糯）の別	5個体	観察			粳						糯		直接又はヨード・ヨードカリ反応による玄米の観察
10	出穂期	区	観察	月 日										全個体の50%が出穂を始めた日［「出穂」とは穂の一部分（芒を除く）が葉鞘から現れたことをいう］
11	穎色	区	観察		黄白	黄	黄金	赤黄～枇	褐～茶	赤褐～褐	紫	黒紫	その他	成熟期（出穂後3週間目）における穎色
12	芒の有無と多少	区	観察	無	微	極少	少	やや少	中	やや多	多	極多	甚	少：10%，中：25%，多：40%
13	芒長	10籾	測定			極短	短	やや短	中	やや長	長	極長		有芒籾についてその長い方から30%の籾について測定した平均．短：2cm，中：4cm，長：6cm

Fig. 2 Example of output by printing program for guidelines (the primary traits on rice)

植物遺伝資源特性調査記入表

(01001)
作物の種類　稲　　1次必須項目　　調査機関名＿＿＿＿　部室名＿＿＿＿　記入者＿＿＿＿

植物名＿＿＿＿　植物番号＿＿＿＿　調査機関コード＿＿＿＿　部室コード＿＿＿＿　調査年＿＿＿＿　播種期（定植期）＿＿＿＿

品種系統名	パスポートデータ整理番号	稈長（cm）	穂長（cm）	穂数（本／個体）	ふ先色	籾長（mm）	籾幅（mm）	玄米長（mm）	玄米幅（mm）	うるち（粳）・もち（糯）の別	出穂期	葉色	芒の有無と多少	芒長	
		1	2	3	4	5	6	7	8	9	10	11	12	13	

Fig. 3　Example of output by printing program for description form (the primary traits on rice)

(3) Printing program for description form for evaluation data of the primary traits

Description forms for evaluation data of the primary traits is printed by this program (Fig. 3). The evaluation tests of the primary traits of genetic resources are conducted at the sub-banks of GB of MAFF. This program is developed by SHOU with C language.

(4) Printing program for description forms for item evaluation scheme

Description forms for a total of item evaluation schemes at sub-banks of GB of MAFF is printed by this program. Varieties for each evaluation test at the sub-banks are chosen by the respective sub-banks. Therefore, summed data of this form which indicates item evaluation scheme with variety name, evaluation items and etc. makes it possible to understand actual situation of the evaluation test for genetic resources of each plant species. This program is developed by TAKEDA.

(5) Management program for summing data

This program has a function of input, modification and deletion to manage the description form made by the above (4) program. This program is developed by UMEHARA with informix-4GL language.

(6) Summing program

Tables of summed input data by the above (5) program are printed by this program. This is developed by TAKEDA.

By using above programs stated in (4), (5) and (6), our management of genetic resources evaluation test at more than 100 sub-banks can be systematically executed under the efficient control of main-bank of GB of MAFF.

5. Schedules for further development

The proposed system is a premise to manage item evaluation data of plant genetic resources. Data performed by this description system should be stored in the database as many as possible, and item evaluation data management program has to be developed to manage these data.

One big problem is that items for evaluation are different from a plant species to another. In a conventional sense, each plant species needs respective

management program, but it is difficult to develop more than 100 different management program for each plant species. The main object of storing item definition data in the database is to manage item evaluation data of all plant species by one item evaluation data management program using item definition data. Prototype program is being developed by using C language since the spring of 1990, and is expected to be completed by UMEHARA in the near future.

Passport data management system has been distributed to the sub-banks of GB of MAFF, and we are planning to strengthen data management system including item evaluation data management which will be conducted at every sub-bank in future.

6. Note of glossary

Guidelines:	A form of item definition at the MAFF GB.
Item definition data :	Information which defines items of traits and description manner for each crop.
Multiuser-OS :	Operation system which is possible to operate one computer by plural users.
UNIX :	The name of operation system which was established by AT & T Bell Institute.
Relational database :	A kind of database which can manage data as a set of plural tables.
Scheme :	Structure of database which defines relation the structure of tables and their relation.
Informix-4GL :	Language for developing database application.
C language :	Language which is established for developing system program is employed widely by UNIX.

7. References

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