Utilization of Yunnan Rice Germplasm Resources in Rice Breeding

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Abstract

The Yunnan Province of China is one of the centers of diversity of Asian cultivated rice (*Oryza sativa* L.). Its rice genetic resources are of great importance worldwide in terms of diversity of varieties abundance and complexity of types. This paper places emphasis on the genetic resources utilized for breeding programs in Yunnan including the collection of germplasm and evaluation of characters as well as investigations on wild and cultivated species. Achievements have been obtained in breeding for high yield, cold tolerance, blast resistance or quality and all the improved varieties show characteristics suitable for highland and standard agriculture. Many materials which include valuable germplasm for breeding, display the following characteristics : ultra-large ear weight, high tolerance to cold, high resistance to diseases (upland rice) and high quality comparable to that of Run-rice (indica rice). However, since most of the varieties exhibit a tall plant height, a week tillering ability and a disorganized arrangement of leaves, improvement of the plant type is the first priority in rice breeding. Varieties successfully improved by hybridization are mainly derived from materials from Japan and Taiwan for keng (japonica) rice or from IR lines of hsien (indica) rice used as parents. Intermediate types are less selected as parents because breeders world like to use the lines with a superior plant type. The abundant rice resources in Yunnan are not fully exploited and utilized and breeders should pay attention to this problem in further studies.

Yuunan rice germplasm resources

1 Investigation, collection and management

The investigation were carried out by CAAS, the former SWAI, YAAS, etc., in 1956-1957, 1960-1965, 1974 and 1978-1980, 4 times in all.

1. Wild rice: 101 areas with wild rice were identified in the southwestern and southeastern parts of Yunnan, including common wild rice (*Oryza rufipogon* Griff), warty-grained wild rice (*O. Meyeriana* Baill) and medicinal wild rice (*O. officinalis* Wall) (Yunnan Rice Germplasm Investigation Group,1988). The number of areas in relation to the distribution of wild rice varieties was in the order of *O. meyeriana* > *O. rufipogon* > *O. officinalis*. The former two consisted of 3 groups each and the latter did not show any group differentiation.

2. Cultivated rice: 6,000 and more accessions of rice varieties, with germinating ability, have been accumulated, including 5,128 accessions tested and rearranged in the field and laboratory. They were included in the Yunnan Provincial Rice Germplasm List, of which 2,434 accessions consist of hsien rice (2,329 accessions of paddy rice and 105 of upland rice) and 2,694 accessions consist of keng rice (1,622 of paddy and 1,072 of upland rice). Based on the morphological and cultural characteristics, the following types were preliminarily classified qermplasm (Resources Station of YAAS, 1984) (Fig. 1). In general, Yunnan rice varieties exhibit 3 principal characteristics: many varieties contain anthocyanidin; many belong to the

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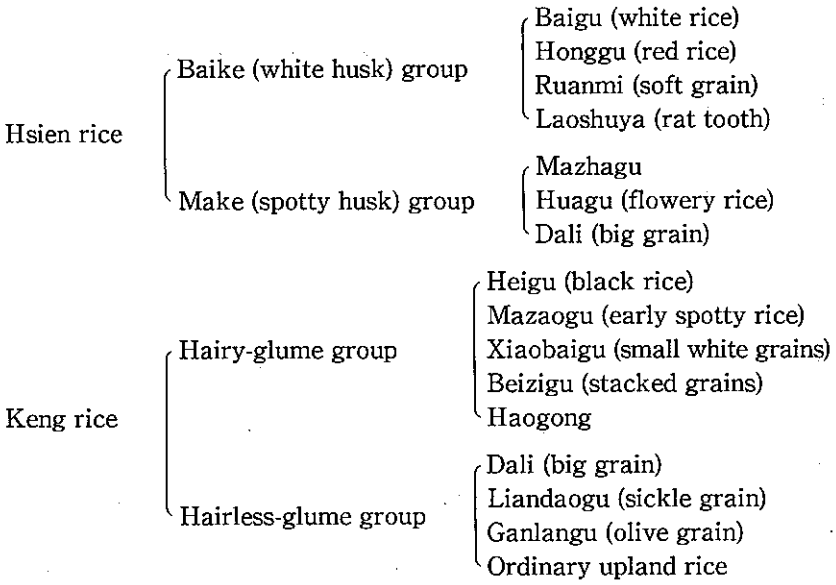


Fig. 1 Types of Yunnan rice

glutinous rice type with a considerable number having a sweet smell; and many show smooth husks.

2 Characterization

1. Plant characters

The height ranged from 61-210 cm, with a smaller number of tillers, a rather spreading flag leaf 10-65 cm×0.7-3 cm size, 10-36 cm panicle length, 30-340 grains/panicle, 1000-grain weight from <20 g to 52 g, 5-13 mm×2.4-4.9 mm grain size. In general, since many varieties show large panicles and grains, they are valuable materials for high-yield breeding. The only disadvantage is their greater plant height, smaller number of tillers and undesirable plant architecture.

2. Response to light and temperature

There are few early varieties of hsien rice in Yunnan, as well as late-ripe early keng rice, and no early-ripe early keng. The main proportion consists of late rice, both hsien and keng, and few varieties of middle ripening rice. The materials show a weak response to light and moderate response to temperature, but are relatively tolerant to low temperature. The presence of more than 60 short days with a high temperature in the growing period is favorable for breeding in Yunnan (Lu Xixuan *et al*., 1985).

3. Cold resistance

2,763 accessions evaluated for their cold resistance at the germinating stage at 5°C by the Germplasm Station of YAAS included 9 highly resistant, 60 resistant and 146 relatively resistant accessions. The other were only weakly and very weakly resistant. Yunnan leads the country in keng rice with cold resistance at the booting and flowering stages, with the highest level of resistance found in Lijiang Xintuan Heigu (black rice), Kunming Xiaobaigu (small white rice), Banjiemang (half awn) and other cultivars (Chen Yong *et al*., 1990). More resistant cultivars were also found in the hsien rice varieties, such as Dali Early Hsien and Biwusheng.

4. Disease and pest resistance

1) Rice blast: 4,735 cultivars were inoculated with a fluid mixture containing 7 Chinese strains for evaluation of natural leaf and neck blast at the seedling stage and in the field. Among them, 162 accessions were found to be resistant to seedling, leaf and neck blast. It was observed that there are a larger number of antigens in the Simao and Banna regions and that the number of antigens decreases with the increase of the latitude and altitudes; the order of resistance from strong to weak is: keng upland rice > hsien paddy rice > hsien upland > keng paddy rice (Germplasm Resource Station of XAAS, 1987).

2) Rice bacterial blight: 4,092 accessions were inoculated with "Jiangling 691" and no immune cultivars were detected (Chen Yong *et al*., 1990).

Table 1 Pest resistance of Yunnan rice germplasm

Resistance grade / Pest	1	3	5	7	9	Total number of accessions
White-backed planthopper	23	175	601	471	909	2,129
Brown planthopper	17	42	132	343	2,239	2,773

3) Pest resistance: Only the resistance to planthoppers has been evaluated preliminarily. Grade 1 resistance to the white-back and brown planthoppers was detected in 23 and 17 accessions, respectively (Table 1).

5) Other characters: The "Zhefang rice", "Babao rice" and many fragrant types of rice as well as purple rice germplasm in Yunnan are highly appreciated, although only few studies are available. In 1,535 accessions the protein contents ranged from 4.5 to 15.5%, averaging 8%, but the flavor was not analysed. In addition, although drought and salt tolerance have been evaluated preliminarily, these characters are not being utilized for breeding and they are not well documented.

History of Yunnan paddy and upland rice production and breeding

1 Production

The climate is complex in Yunnan. Although the elevation varies considerably, rice is distributed widely, from 76 m asl at Hekou to 2,700 m asl at Yongning Town, Ninglang. Area of land planted to rice amounted to 1,061,000 ha per year in 1981-1990, with a yield of 4.4 t/ha at a total production of 4,668,400 tons; hsien rice covered 423,000 ha, keng rice 479,000 ha and keng upland rice 124,000 ha in 1990. The Province was divided into 6 rice-growing regions by Cheng (1986). Yields vary greatly with the areas. The highest yields of 15.5-6.7 t/ha in general, are found in the hsien-keng-interlocking region (1,500-1,800 m) of central Yunnan. In a small number of high-yielding basins such as Yuxi, Jiangchuan, Chengjiang, Yiliang, Baoshan, the yields amounted to 7.5-9.2 t with the semi-mountainous areas yielding 20-25% less than the basins and mountainous areas 35-40% less, the alpine areas about 50% less, and about 2.2-3.4 t/ha in Northwest Yunnan cold areas. Upland rice covered an area of 131,000 ha, with an average yield of 1.56 t/ha in the Province in 1987.

2 Breeding history

The improvement of rice varieties went through 4 general phases, the varieties in use in Yunnan having been changed 5 times. In the 1 st phase, 1952-1957, mainly desirable local varieties were evaluated and popularized, such as Eshan Dabaigu, Yiliang Luanjiaolong, Chuxiong Maxiangu, Qujing Haipaigu, Zhaotong Dabaigu, Dianxi (West Yunnan) Shayanggu, etc., to replace ordinary local varieties. In the second phase, from the late 1950s to the 1960s, cultivars 129, 373, 65-36, 8126, Baoshan 1, etc. were selected systematically from hybrids of indigenous or introduced elite cultivars in areas at about 1,900 m asl in central-north Yunnan based on various breeding sectors; lowland cultivars of keng rice. Taibei 8, Taizhong 31, SW (southwest) 175, Laolaiqing, Nongken 58, Nonglin 22, Keqing 3, etc. were introduced successively to central Yunnan high-yielding areas, gradually replacing the local tall, large-headed hsien rice varieties, to achieve the "Changing hsien into keng" project; hsien cultivars, Pearl Dwarf, Guangchang Dwarf, Boluo Dwarf, Guanger Dwarf, etc., were introduced to the hsien-rice-growing regions of south Yunnan. In the 3 rd phase, in the 1970s, the acreage of SW 175 expanded and it became the leading cultivar grown in central Yunnan. Yunkeng 2, Yunkeng 5, Yunkeng 9, 75-64, 65113, Jinguo 92, etc. derived from SW 175 through systematic selection of natural hybrid plants, and high-yielding Dianyu 1, etc. were also hybridized and popularized in the hsien-rice-growing regions. In the 4th phase, from the 1980 s till now, highly coldresistant cultivars, Heixuan 5 and Likeng 2, have been bred in the cold-high-mountainous area, while the cultivars Yunkeng 136, Yunkeng 219, Yunkeng 135, He (Grane) 16, etc. with heavy panicles bred in the

central-north region, Chukeng series and Yunyu series bred in the central region, hybrid rice and Guichao 2, Aizhonghsien, Dianlong 201, Dianrui 408, etc. are the leading cultivars grown in the hsien rice regions. Coop. series bred through Sino-Japan cooperation have been popularized rapidly since 1989. The Coop. cultivar area amounted to 67,600 ha in 1992.

Table 2 Changes in acreage of leading rice cultivars popularized in Yunnan from 1979 to 1992 (10,000 ha)

Asl	1,500m (Hsien)					1,500-1,800m (Keng)					1,800-2,100m (Keng)				
Cv / Year	Hybrid rice	Guichao 2	Aizhong Hsien	Dianlong 201	Dianrui 408	SW 175	Chukeng series	65-36	Jingguo 92	Yunyu 1	8126	Kengdiao 3	Yunkeng 9	Yunkeng 136	Coop. series
1979	2.35					1.27					2.87	0.53	1.80		
1980	0.62		1.02			7.90		1.08			3.89	1.28	2.90	0.09	
1981	1.24	0.07	—			6.33		0.79	0.27		3.45	1.91	4.73	—	
1982	1.39	0.40	2.25			6.85		1.65	0.65		4.89	2.84	3.35	1.39	
1983	2.87	1.73	1.79			7.03*		1.67	0.97	0.13	3.83	2.21	2.53	0.69	
1984	5.53	4.02	2.33	0.48	0.25	8.35	0.22	1.49	1.20	0.47	3.81	1.37	0.80	1.04	
1985	8.56	2.25	0.93	0.94	0.31	5.91	0.79	1.33	1.15	0.59	3.79	0.80	—	1.14	
1986	10.89	2.57	0.57	0.79	0.53	4.08	2.77	2.55	1.30	0.69	3.72	0.41	0.99	2.29	
1987	15.13	2.55	0.44	0.74	0.49	3.83	4.82	2.22	1.40	0.73	3.10	0.30	0.74	2.47	
1988	20.15	1.81	—	0.59	0.31	3.21	5.61	2.23	1.35	0.78	2.34	0.35	0.72	2.37	0.07
1989	21.25	2.06	0.23	1.13	—	2.83	7.10	1.78	1.53	0.89	2.99	0.33	0.28	2.73	0.55
1990	23.99	2.15	—	0.49	0.25	2.09	7.70	—	—	0.79	2.70	0.29	0.45	2.19	2.33
1991	27.37	2.03	0.18	0.26		1.81	8.55	1.01	1.01	0.73	2.25	0.25	0.37	1.27	4.00
1992	29.18	1.65	0.23	0.75	0.57	0.97	9.00	0.67	0.67	0.38	2.29	—	0.21	1.49	6.67

Note: Part of Coop. series was grown in areas at 1,500-1,800 m asl.

It is particularly noticeable that in the 76 keng rice cultivars already bred and listed in the Yunnan Rice Varieties Annals, 31 are derived from SW 175 (Seed Management Station of Yunnan Province), in addition to 5 unlisted ones.

In addition, statistically the improved cultivars covered an area of 831,900 ha in 1992, including 291,800 ha of Coop. series. The changes in the leading cultivars popularized in Yunnan from 1979 to 1992 are listed in Table 3. Those not listed covered less than 10,000 ha each, which indicated that complicated climate and landform account for the small area of each improved cultivar. In spite of the small area cultivated with Dianlong 201 and Dianrui 408, these cultivars are excellent soft rice.

3 Breeding sectors and their objectives

Breeding work in Yunnan is fundamentally determined locally according to the altitude and ethnic usage of rice. The major breeding sectors and their objectives are indicated in Table 3. Due to the popularization of hybrid rice over a large area in recent years since the Lincan, Honghe and Wenshan regions have stopped breeding hsien rice cultivars, they are not listed in the table.

Utilization of Yunnan rice germplasm resources for breeding

Rice breeding work in Yunnan was initiated in the 1970s and gradually provided new cultivars for production in the 1980s. Most of the new cultivars were bred from the improved varieties while fewer cultivars were bred through the direct use of the farmers original varieties as parent materials. This is mainly due to the undesirable plant architecture of the indigenous varieties and also due to their stronger genetic conservation. Moreover, Yunnan formerly lacked suitable improved cultivars of dwarf types and the hybrids of the local materials, crossed with introduced ones, mostly gave unsatisfactory performance

Table 3 Yunnan rice breeding sectors and their objectives

Breeding sector	Breeding objective	Breeding sector	Breeding objective
Lijiang Agri. Inst. (2,393 m)	Cold resistant cultivars for regions at 2,100–2,700 m asl	Chuxiong Agri. Inst. (1,772 m) Baoshan Agri. Inst. (1,653 m) Yuxi Agri. Inst. (1.636 m) Sino-Japan Yiliang Spot (1,532 m)	High-yielding, disease-resistant, quality, shdding-seed-type keng rice cultivars for regions at 1,500–1,800 m asl
Dali Agri. Inst. (1,990 m) YAAS (1,916 m) (including Sino-Japan items) Qujing Agri. Inst. (1,906 m) Kunming Agri. Inst. (1,891 m) Jingning Agri. Inst. (1,891 m)	High-yielding, cold and disease-resistant, quality cultivars for regions at 1,800–2,100 m asl	Dehong Agri. Inst. (914 m) Ruili Rice Station (776 m)	Soft hsien rice breeding
		Xishuangbanna Agri. Inst. (553 m)	Glutinous hsien rice and upland rice breeding

Note: The elevation of the breeding site is indicated in the parentheses.

due to geo-ecological outcrossing.

Regardless of the breeding objective, for cold or disease resistance or for quality, the common goal is to achieve high yield. Considering the characteristics of Yunnan rice germplasm resources and their utilization, the author intends to introduce different aspects of utilization separatly, i.e., utilization for breeding for high-yield, cold resistance, blast resistance and quality.

1 Breeding for high yield

For many years, in the breeding of high-yielding varieties of Yunnan rice, particular attention has been paid to the improvement of the plant architecture of germplasm accessions with large panicles and graines. K. S. Cheng (1978) suggested that varieties with very large weight, large panicles and grains should be bred and Yang Shixuan *et al.* (1982) reported progress in this kind of breeding. Later, it was reported that large panicle cultivars produced fewer panicles and higher rates of empty grains, hence high yields could not be achieved. Jiang Zhinong *et al.* (1983) considered that for a breakthrough in yield of Yunnan keng rice a large number of panicles should be obtained before the increase of the number of grains per panicle and increase of grain weight. He proposed the high-yielding breeding model of "intermediate types" in the Sino-Japan cooperative rice breeding research project initiated in 1983.

In keng rice breeding, about 11 high-yielding cultivars were bred by utilizing Yunnan germplasm resources, including 9 bred through interlinear crossing and 2 through triple crossing (Table 4).

The above parental analysis shows that Keqing 3 and SW175 are found in 3 combinations each and the parent materials belong to the keng dwarf plant type with suitable architecture. As a result, the improved Yunnan local cultivars possess the cold resistance of Yunnan cultivars. In particular, Dianyu 1 has a good plant architecture as well as a suitable panicle-grain structure since its root system is very vigorous in the late period (it produced 15 t/ha, at Nancun, Dali in 1984, a record high yield in keng rice production).

In the hsien rice breeding, 8 cultivars have been bred using Yunnan local farmers' varieties as parents (Table 5). The other parents of these 8 cultivars consist mainly of the IR system with good plant architecture and of the hsien dwarfs bred in Guangdong. These cultivars, however, have been disseminated to an area of only 10,000 ha each.

2 Breeding for cold resistance

1. General situation of cold damage of Yunnan rice and germplasm resources with cold resistance.

Climate and cold damage situation in the rice-growing regions of Yunnan plateau has been reported in many publications. The main causes of cold damage are: 1) high elevation with low temperature (Table 6), 2) frequent occurrence of cold air, and 3) booting and flowering stages occurring in the rainy season with less sunlight, which enhances the cold damage.

Most of the keng rice local varieties on the Yunnan plateau are cold resistant to a moderate degree and some of them are more resistant than the Japanese Somewake and the Indonesian Silewah varieties. As they display the highest quality and exhibit local adaptability as well, they are valuable materials for

Table 4 Keng rice cultivars and their combinations

Cultivar	Combination
Dianyu 1	Yinyuan Purple Glutinous/ Keqing 3
Kunming 217	Keqing 3/ Kunming Beizigu
Practice rice	Keqing 3/ Ludian Dabeizi
Dianxun 8	SW 175/ Heibanjiemang
Xihong 2	SW 175/ Wuding Dabaigu
Baibahao	Baizai/ Tuanjie Daheigu
Ziyu 44	Huanglagu/ Torite 2
Zhannuo 1	66-46/ Xuanwei Danuogu
Mile 417	Chuandakeng/ Dabainuo
A 210	174/ Dabaigu// Jinning 277
Dianxie 1	SW 175/ Kunming Heikemazao// Luo 851

Table 5 Hsien rice cultivars and their combinations

Cultivar	Combination
Chuhsien 1	Nantezhan/Biewusheng
Zhujongzhan 1	Zhujiangjia 13/Mazhangu
Kesha 1	IR 8/Shayanggu
Dianmeng 2	IR 8/Yuanjiang Dahonggu
Dianla 1	Kunming Hongdiao/IR 22
Dianying 1	Babaomi/IR 20
Banna 3	Lizao 3/Shuihun
Huangsha 1	Huangpiai/Shayanggu

Table 6 Average temperatures (℃) in Yunnan keng-rice-growing regions from July to September

Region	Yiliang	Yuxi	Baoshan	Chuxiong	Kunming	Qujing
July	21.7	20.9	20.8	20.7	19.8	19.9
Aug.	20.9	20.3	20.4	20.1	19.1	19.0
Sept.	19.4	19.1	19.4	18.7	17.5	17.2
Region	Zhaotong	Dali	Malong	Heqing	Lijiang	
July	19.8	20.1	18.1	19.2	18.0	
Aug.	19.0	19.3	17.2	18.3	17.2	
Sept.	16.1	18.1	16.6	16.8	16.0	

cold resistance breeding. However, these germplasm accessions consist of tall plants with a large number of red kernels and purplish brown or black husk that are susceptible to rice blast. Moreover the plant architecture and quality are not suitable. Their progenies derived from interlinear crossing combinations seldom show a suitable plant architecture and high seed-setting rate.

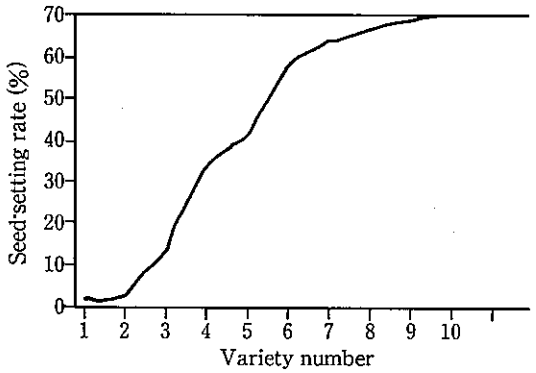
2. Cold resistance of Yunnan keng rice cultivars

For the past 20 year, Yunnan has bred about 200 varieties and lines of keng rice. In 1990-1991, they were evaluated for their cold resistance at Shuangshao, a mountainous district to Kunming (2,140 m asl).

Table 7 Cold resistance of Yunnan keng rice cultivars

Breeding site	SS	S	MS	M	MR	R	RR
Kunming (86)	10	6	13	20	18	19	0
Chuxiong (47)	6	7	6	11	10	7	0
Yuxi (28)	21	3	2	1	1	0	0
Baoshan (18)	14	2	1	1	—	—	—
Qujing (11)	1	4	2	1	1	2	0
Lijiang (10)	0	0	0	1	1	5	3
Japan (7)	3	1	0	2	0	1	0
Total	55	23	24	37	31	34	3

For comparison, 7 Japanese cultivars commonly used as parents were added. Among these 207 cultivars (lines), only 3 of them were highly resistant (RR), all of which were bred in Lijiang; 34 of them were resistant (R) including the Japanese Chuubou 42; 68 of them were moderately resistant (MR) to highly susceptible (SS) (Table 7). To sum up, cultivars bred at higher elevations display a stronger cold resistance.



Note: 1. Han 9; 2. Silewah; 3. Somewake; 4. He 16
5. Yunkeng; 6. Yunertian 01; 7. Dianjing 8; 8. Heixuan 5
9. Coop. 37; 10. Likeng 2

Fig. 2 Cold resistance of Yunnan keng rice cultivars

Yunkeng 9, grown in regions at 1,900-2,000 m asl in Yunnan for many years, shows a good cold resistance (Grade R). However, it cannot be grown in regions above 2,100 m asl. In regions at 2,100-2,500 m, 6 cultivars, Heixuan 5, Likeng 2, Dianjing 8, Kengdiao 3, Yunertian 01 and He 16, are grown over a larger acreage. Yang Dingzheng's studies (1988) showed that Heixuan 5 can tolerate a low temperature of 12.5°C at the flowering stage. Recently bred Coop. 37 (Coop. 5/Likeng 2) is as resistant as Likeng 2 and exceeds Likeng and He 16 in quality and productivity. Seed-setting rates of different cultivars (lines) at Shuangshao in 1992 are shown in Fig. 2.

3 Breeding for rice blast resistance

Rice blast, bacterial blight, rice stripe and rice false smut are the main diseases of Yunnan rice. With the exception of rice blast, breeding for resistance has not been achieved.

1. Blast physiological races and their pathogenicity in different rice-growing regions of Yunnan

Composition and distribution of the races differ greatly. The races 007, 003 and 117^t occur frequently in the plateau rice region; 303^b is obviously dominant in regions with single cropping of late hsien rice; 001 and 003 are more often observed in hsien-keng interlocked regions. Fewer strains were isolated in paddy-upland rice regions, with 002^t and 003^t occurring more frequently. It is noticeable that a larger quantity of race 000 isolates occur in the alpinecold rice regions and single cropping hsien rice regions. In addition, the highest pathogenetic frequency of Yunnan rice blast is found in k^s and a genotype (over 95%) followed by i, k (40-50%), k^s (14%) and b (1% or so). No pathogenicity is observed in the z, ta^2 and z^t genotypes (Li Chengyun *et al.*, 1990).

2. Utilization of disease-resistant germplasm resources for breeding

For the breeding of keng rice, the resistance is mainly derived from cultivars of Yunnan upland rice, such as Sanfuqishiluo, Banli 1, Haobuca, Mengwangu, Mowanggu and Haonaihuan. Yunxi 2 and Yunkeng 33, bred by the Rice Section of YAAS using Sanfushiluo, are highly resistant to diseases. According to a preliminary study, Yunxi 2 harbors a pair of resistance genes. Yunqing 1-4, bred by using Mengwanggu and Haonaihuan, was used as intermediate parent with a superior plant architecture in crossing, and some outstanding series were bred successfully.

In the breeding of hsien rice, some cultivars have been successfully bred by using Shayanggu, Haomuxi and other Yunnan cultivars with high disease resistance. However, since the other parent mainly belongs to the IR system with disease-resistance, hence the origin of resistance in the cultivars bred remains to be studied further.

4 Breeding for quality

Although, there are many rice cultivars with high quality in the Yunnan rice resources, since too much attention had been paid to the high-yielding character, accessions with high quality had not been utilized in the past. The new keng rice cultivars, Shexi 4, Coop. 5, Zhankeng 6 and You 4-10 bred in recent years, were evaluated as the first set of quality rice in 1991, great improvement being made in their appearance and flavor. However, the flavor still lags behind that of Yueguang and they are not bred from Yunnan local cultivars either. In breeding for quality, the optimum results, in the utilization of Yunnan rice germplasm, were obtained with soft hsien rice and glutinous rice.

Since soft rice had long been appreciated by the Dai people in Yunnan's Dehong region and glutinous rice preferred among the same people in the Xishuangbanna region, the agricultural institutes of these two regions and Ruili Rice Station of YAAS have used these local germplasm resources to improve the plant architecture and they bred a set of high-yielding, soft rice and glutinous rice cultivars (Table 8), including the soft rice cultivars, Dianlong 201, Dianrui 408, Dianrui 449, evaluated by the Agriculture Ministry as

Table 8 Soft rice and glutinous rice of hsien type

Cultivar	Combination	Quality
Dianlong 201	Haomuxi/ IR 24	soft
Dianrui 408	do	soft
Dianrui 409	Haomuxi/ Keqing	soft
Dianrui 410	Haomuxi/ IR 22	soft
Dianrui 449	Dianrui 409/IET 2238// IR 42	soft
Dianrui 306	Dinuo/ IR 24	Fragrant glutinous
Yunxiangkeng 1	IR 29/ Haonuogan	do
Purple 1	Haohaogui// Guangerai/ IR 24	Glutinous
Ganbo 1	Haoxianggungan// IR 22// Boluoai	do
Banna 4	IR 29// Yinfinuo//Haonuobi	do

quality rice. The production of soft rice cultivars is specific to the Dehong Region. The soft rice which is called "Zhanmi" is neither glutinous nor non-glutinous rice. The cooked soft rice grains adhere to each other, appear lustrous and oily, taste good and remain soft when cold. The Dai farmers always carry cold cooked rice to work in the mountains for meals.

Better results could have been achieved in the utilization of the Yunnan rice germplasm resources, in taking account of the Yunnan resources, if the following conditions could be improved 1) systematic identification of various characteristics of Yunnan rice resources is lacking; 2) cross breeding started rather late, and parent materials with superior plant architecture suitable for the local conditions were also lacking before the 1980 s; 3) since most of the local cultivars belong to the tall plant type with a low tillering ability and with leaf blades spreading, it is difficult to utilize them directly. Although it is very important to breed elite intermediate parents, this work was seldom carried out in the past. All these problems are being studied for further research.

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Discussion

Riley, K. (IBPGR): I was intersted to learn that rice is grown at high elevations (2700 m) in Yunnan. In the highland valleys in Nepal rice is grown up to 2800 m. Has there been any exchange of cool-tolerant rice germplasm between Nepal and Yunnan Provice in China.

Answer: There is no exchange of germplasm with Nepal.

Kaneda, C. (Japan): What is the meaning of "rat tooth" and "flowering grain" in the rice variety groups? Does the term "soft" shien rice mean that cooked rice is soft and moist?

Answer: "Rat tooth" means that the grain shape is like a rat tooth. The term "flowering grain" is used when the grain has a husk with uneven color (dark and light color). "Soft" rice means that after being cooked the grain is soft and remains soft when rice gets cold.