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RICE BREEDING IN MALAGASY REPUBLIC

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Introduction

Rice has been cultivated for centuries in the Malagasy Democratic Republic (formerly Madagascar) and it is the staple food of most of the population. During this time, there have been a large number of varietal introductions. Also, a great diversity of ecosystems exist on the island, which range from tropical-humid to semi-tropical conditions and from altitudes of sea-level to 2200 m, the highest altitude on the island at which rice is grown on a large scale. These factors have resulted in a large number (1,200) of rice ecotypes of varying degrees of importance.

Rice cultivation in Malagasy is complex because of the diversity of ecosystems, ecotypes, crop seasons and farming systems. Most of the rice is grown under irrigated conditions. Breeding has played an important role in rice improvement and both local ecotypes and introductions have been used in hybridization and mutation breeding.

Breeding Programme

Local ecotypes

Rice was probably introduced into Malagasy by the original inhabitants who navigated from Indonesia sailing across the Indian Ocean from east to west, either directly or via Sri Lanka or southern India. This explains why one frequently finds amongst the good Indica types many Javanese ecotypes (e.g. Makalioka in Lake Alaotra area, Tsipala in the southwest). The varieties, such as Vary Lava, which are grown in the centre of the island are quite similar to some varieties in the Philippines.

Over the centuries, new types have emerged, because the ecosystems have exerted pressure for genetic change. There has been some farmer-selection of same types

there have been recombinations due to natural hybridizations or mutations. The result has been a large diversity of rice ecotypes, all derived from Indica and Javanica types, spread throughout the island.

There are approximately 1,200 ecotypes, which may be classified into several large groups. These are represented by varieties Tsipala, Makalioka and Fandrapotsy in the west and north-central zones; Lava, Rojo and Botry on the high plateaux; Bengala and Be in the north; Vato, Tsipala and Lava in the northwest; and Latsy in the highlands.

Selection

The earliest selections were made by the farmers themselves. Even today, it is common for farmers to select panicles and to mix certain ecotypes, such as Tsindrilahy, in the central part of the island. Research work commenced in 1927 at the Marovoay Agricultural Station in the northwest and later at the Alaotra Lake Station.

Pedigree-breeding was commenced by selecting panicles from local crops. High yielding varieties such as Makalioka 34, Vary Lava Marovoay 47, Ali-Combo, Tsipala A, and Rojofotsy 1285, were developed. The first three of these are presently cultivated on thousands of hectares throughout the country.

Since 1960, new varieties have been developed from previously collected local ecotypes. The new varieties include Boina 1329 and RS 25T for upland rice, especially in the northwest.

Some local ecotypes have been shown to be high-yielding when grown under good conditions, e.g. Ambalalava 1283, Vary Vato 462, Sandramaditra and Rojofotsy. Recently, selection among the local ecotypes from the high altitude areas produced three strains of the variety Latsika which gave higher yields than the unselected local type.

Varietal introductions

Approximately 1000 varieties have been introduced over the past 30 years, and these have been carefully tested for their suitability under various conditions. Certain varieties, notably Chianan 8 from Taiwan, performed well in all locations under 1600 m. It gave an average yield of 5 t/ha over 11 years. It outyielded the local varieties in all districts except one. Some varieties behave fairly well in most localities, and well in one particular area, e.g. Taichung Native 1, IR8, IR20.

None of the introductions were suitable for altitudes above 1600 m. The local material is unique in being adapted to these areas. Some of the introductions yielded well in the first year, but their yields fell sharply after that, usually because they lacked tolerance to the prevailing pathosystem.

Some exceptionally good yields have been obtained from introduced varieties e.g. Chianan 8 in Fianarantsoa and Tananarive regions, 10 t/ha; Taichung Line 137 at Fianarantsoa, 12 t/ha. These were usually the highest yielding of all varieties throughout the island.

Multilocational trials

The results from more than 10,000 trials conducted between 1962 and 1975 were summarized in an IRAT (Malagasy) report in 1976. The trials showed that yields were better at higher altitudes (8 t/ha) than at the coast (5.5 - 7 t/ha). However, there is a potential for 2 crops per year on the coast, which would give a total annual yield of 12 t/ha. Higher yields were produced in the cool season than in the hot season. Yields of local varieties often remained low despite improvements in cultural practices.

Maximum yields increased from 1962-1968, but tended to fall after this, despite the same fertilization. Many reasons have been suggested for this, such as lack of minor elements, iron toxicity, and stress due to pathosystems.

The average yield of local varieties in experimental plots was 4.4 t/ha, compared with 2.9 t/ha in farmers' fields. This indicates that the average farm yield could be increased considerably by improved cultural techniques. Of 10,400 results, about 7% gave yields of 7-12 t/ha, indicating the excellent potential of some of the rice lands in Malagasy.

The percentage of acceptable varieties amongst those tested decreased with increasing altitude. It was 50% at sea-level, 20% at 1200 m, 5% at 1600 m, and 0.1% at 2000 m.

The yields were seldom stable and varieties which performed well over time in a specific ecosystem were exceptional, e.g. Chianan 8 at Tananarive (1200 m). Varieties which yielded more than local checks were Japonica types for 40% and Indica-Javanica types for 60%. However, above 1600 m the local varieties were the only suitable types.

Hybridization

The crossing programme has involved 738 crosses from 308 parents. 465 lines from 53 parents have been recorded in local catalogues. The following conclusions were drawn:

a) Indica x Indica crosses were undesirable except for grain quality.
b) The farther apart the parents were genetically, the less frequent were interesting recombinations, but the more potentially useful these were.
c) It was found preferable to make relatively few

crosses, but to select the parents carefully and to study the F_2 generation on a large scale. Approximately 100,000 individuals of an F_2 population were examined to find interesting recombinants. It was rare to find such recombinants in an F_2 population of 5000 individuals when the parents were genetically diverse.

d) The genes for semi-dwarfness were eliminated in the programme because they frequently led to undesirable characteristics. Transgressions frequently occurred during crosses between remote parents, so that reduced height could be obtained without the introduction of undesirable traits.
e) It was not difficult to obtain desirable phenotypes, such as lines 2523, 2532, 2619 or 2595, by using the amount of interchange that occurred in some crosses.
f) Indica x Ponlai crosses were particularly useful.
g) Back-crossing did not give valuable recombinants.
h) Bulk-crossing was abandoned after several unsuccessful attempts and the single-line method was preferred.
i) Male emasculation was carried out with hot water, using well-established procedures.

Mutation

Twenty-six varieties were studied and 21 useful lines were derived from them by mutation. Low dosages of chemical and physical mutagens gave the best results, using either 15 Kr gamma radiation, 0.9% MSE for 24h or exposure to MSE gas for 8-12h. The use of MSE gas was preferable since it avoided secondary effects due to hydrolysis, and was simple and efficient.

There was a large spectrum of mutants for several varieties. The mutants were similar, irrespective of the method used to obtain them. However, there were some varieties which produced few mutants. It was sometimes difficult to identify certain mutants which continued to appear in each generation.

Reversion to ancestral types with long straw, loose panicles and highly awned grains was rarely observed. Certain mutants were very transgressive. Some mutants were genetically interesting because they were hypersensitive to iron, had large grains which were often sterile, short straw (few cm) or compact panicles. Some mutants such as awnless were easily obtained, because of the recessive character of the mutation.

Extension

The results of multilocational trials over 15 years showed that it was possible to significantly increase yield and to obtain other desirable characteristics such as shorter cycle, resistance to lodging, shattering, pests and diseases.

Significant yield increases have been measured over the past three years, when the best of the improved varieties have been compared to the local controls. Under good cultural conditions, including fertilization with 80 units N, 50 units P_2O_5 and 30 units K_2O, and weeding, the improved varieties have out-yielded the local varieties by 15-50%, and, in a few instances, up to 100%. The most outstanding example is the Japanese variety, Chinsei-asahi, which yielded 25 t/ha per year, with four harvests.

The major varieties which have been distributed are:
Introductions: Chianan 8, IR532-1-144, Taichung 178, IR20, Cica 4, Tainan 1, Kachsiung 21, Tainung 3, Tomoe Masari, Kagoshima-Hakamuri.
Local selections: Makalioka 34, Boina 1329, Vato 402, Rojofotsy 1285, Ali-Combo, Latsika, 2067, 1300.
Local hybrids: 752, 2523, 2532, 996.

Conclusion

Some of the recommended varieties are already widely grown e.g. Chianan 8 (30,000 ha); Makalioka 34 (50,000 ha); Ali-Combo, Kagoshima-Hakamuri and Boina 1329 (1000-2000 ha). A special case is Rojofotsy 1285 which is widely cultivated on several thousand hectares in the centre of the island, but as various local ecotypes. Considerable progress has been made in varietal improvement in Malagasy over the past twenty years. However, the wider use of improved varieties is essential for further economic development in Malagasy.