Farmers' management of genetic variability in rice

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Anthropological fieldwork undertaken among semi-subsistence rice cultivators in northern Sierra Leone found that a number of farmers practised a technique of intra-specific rice cropping whereby the seed of two carefully chosen varieties – usually a glaberrima and a sativa variety - is intentionally mixed. Farmers who mixed varieties in this way explained distinct gastronomic and agronomic advantages offered by this technique. Although the grain of the glaberrima type retains a slightly hard texture when it is cooked, it is pleasantly filling when eaten. This is because it has high gluten content and is less easily digested. High gluten content is regarded as a positive feature because it makes a person feel full for longer after eating it.

The sativa variety, on the other hand, is much 'lighter' in the stomach, making a person feel hungry again quite soon. The gastronomic advantages of the *sativa* variety lie in the texture and taste of the cooked grain, which is both softer and tastier than that of the glaberrima variety. Thus, the two rice types have complimentary gastronomic qualities in terms of texture, taste, and filling ability. The gastronomic disadvantages of each (hard texture, poor taste, and low filling quality) are reduced when eaten as a mixture.

In the case study area it is not uncommon to see farm plots sown to a mixture of *disi kono (O. glaberrima)* with *samban konko (O. sativa)*. The glaberrima variety is able to withstand drought, whereas the sativa variety is generally higher yielding. A number of farmers explained how they originally mixed the two seed types in carefully chosen ratios for optimum performance and preferred eating qualities. The ratios in which farmers mixed the glaberrima variety with the sativa variety were variable and ranged from roughly 30% to 150%. Seed for the following year is taken from the mixed stands and no particular method of panicle selection is used. Most farmers who intentionally mixed their seed in this way observed that the ratio of varieties in the mixture tends to change over the years, and some farmers add a certain quantity of one of the varieties so as to maintain the optimum ratio. There was considerable difference of opinion as to whether the *glaberrima* or the *sativa* variety became predominant over time. Although *O. sativa* tends to be higher yielding, *O. glaberrima* is considered to be the better upland competitor, particularly on drier soils. In drought years, *O. sativa* may produce a high proportion of empty grains and the more drought-resistant *O. glaberrima* becomes predominant.

Trials carried out over two seasons at the Rice Research Station, Rokupr, Sierra Leone used replacement series analysis. A replacement series experiment contains different proportions of two varieties in mixture in addition to pure stands (monoculture) of each variety. The yields of the varieties in mixture are compared with the yields of the varieties in pure stands to estimate their performance in competition. The purpose was to investigate how one variety influences the other when cultivated in mixtures involving *O. glaberrima* and *O. sativa* types collected from farmers' fields. The experiments were designed to study the effect of water availability on variety mixture; how changes in plant density affect varietal competition under different conditions; and the effects of competition on the agronomic features of the varieties grown in mixture. The results of these experiments are described in full by Jusu (1999). The trials largely confirmed the farmers' observations described below and showed that mixture yields were generally higher than the mean yield of the varieties grown in pure stands.

Varieties imitate one another

Farmers' observations reveal that the rice varieties, when planted together, behave differently than when grown in pure stands. This phenomenon is explained locally by both the competitive nature (known locally as *gbehteh*) and copycat behaviour or mimicry which farmers regard as common among crop species. Rather than a divergence in flowering times and the avoidance of competition, as might be expected, a small number of farmers very clearly report that the varieties appear to imitate one another in terms of flowering and ripening times, panicle size and tillering ability. Experimental results showed that both plant height and the number of tillers tended to converge when the varieties were grown in mixture. The variety that had fewer tillers in pure stand produced more tillers in mixture, and the variety with more tillers in pure stand produced fewer tillers in mixture. Similarly, the height of the shorter variety in pure stand increased in mixture and the taller variety decreased in height when grown in mixture.

When grown on low-fertility soils, the general pattern was that the flowering times of the varieties tended to coincide when in mixture so that they both came to maturity at the same time. This apparent synchronisation in the flowering times of rice planted in mixtures would appear to increase the likelihood of accidental cross-pollination.

Author Malcolm Sellu-Jusu and on-station rice experiment

Competitive interactions and neighbour effects are known to be major factors conditioning adaptive strategy and species diversity (Sano, Sano & Morishima 1984).

Risks decreased

Other agronomic advantages cited by farmers practising this technique of intra-specific cropping include an increased ability to withstand drought, increased resistance to bird attack, reduced lodging, and/or reduced panicle neck breakage. The *sativa* variety, *samban konko*, is known as a rice variety that has little resistance to drought; for this reason it is best planted early on low-lying, moisture-retentive soils. If the rains are late or insufficient, *samban konko* produces empty grains. The *glaberrima* variety, *disi kono*, on the other hand, is better able to withstand drought and can be cultivated on the dry, gravely soils at the top of the slope. A farm plot planted to a mixture of these two varieties will always yield something, even if the rains are insufficient; if the *samban konko* fails, the *disi kono* will succeed. In addition, a small number of farmers suggested that the roots of *disi kono* somehow help the *samban konko* to take up water, thus enabling it to better withstand drought. One farmer explained this by suggesting that *samban konko* sucks water from the roots of *disi kono*.

Most farmers who practised intra-specific cropping also reported that bird damage was reduced on plots planted to mixed varieties. Birds are believed to be attracted to rice as it begins to mature both by its scent and its visual appearance. The slight difference in flowering times and the duration from flowering to maturity on a plot containing *samban konko* and *disi kono* was believed by some farmers to confuse the birds and prevent damage. Other farmers described how the differences in the height and stature of the rice varieties made it difficult for the birds to see that the *disi kono* had flowered and was beginning to ripen. Farmers who did not practice intra-specific cropping tended to cite the same factors as evidence of increased bird attack. They claimed that the *disi kono* attracted birds as it ripened and that the birds not only damaged the *disi kono* but also the *samban konko*.

photo: Catherine Longley

Less yield losses

Farmers also differed in their observations of lodging on a plot planted to mixed varieties. *Disi kono* has a tendency to lodge when it is dry. This can be reduced to some extent on a mixed plot because rather than falling flat on the ground, the rice plants merely lean against the upright stalks of *samban konko*. On the other hand, *samban konko* has a large, heavy panicle and the panicle neck tends to break if the rice is not harvested on time. The damage caused by this breakage can be prevented in a mixed plot because the *disi kono* lodges and causes the *samban konko* to also fall and lie flat on the ground. Once flat on the ground, the panicle neck does not break. It was implied that this was an advantage to those lacking the labour necessary to ensure that harvesting is carried out on time, before the panicle neck breaks. This difference in observations on lodging is most probably related to the different ratios in which the varieties are mixed, and would seem to partly explain the variation in what is considered to be the optimum ratio, mentioned above.

An intermediate rice type?

In sum, it could be argued that intra-specific rice cropping is a risk avoidance strategy adopted by farmers who are short of labour for scaring birds and timely harvesting. Farmers who plant slightly later in the season also incur the risk that *samban konko* may not take sufficient water during its growing cycle. This risk is perhaps reduced when *samban konko* is sown in mixed stands, particularly if *disi kono* does indeed increase the former's ability to take up water. In any case, a farm planted to mixed varieties will always yield something, even if *samban konko* produces empty grains. Research from Nigeria has suggested that farmers practice intra-specific cropping 'because it is safer to obtain stable yields in conditions where the climate fluctuates year after year' (Sano, Sano & Morishima 1984: 253).

It has also been suggested that farmers who practise intra-specific cropping may do so for reasons relating to their choice of farm site (Longley & Richards 1993: 56). In the case study area, crop rotation is practised whereby rice is cultivated in the first year and groundnuts, an important cash crop, in the second year. The slightly gravely, rain-fed sites that are best suited for large-scale groundnut farming are not ideal for the high-yielding *sativa* rice such as *samban konko* which does best on low-lying, moisture-retentive soils. It is possible that some farmers, particularly those who are most dependent on the cash economy for their livelihoods, prefer to select farm sites that are most suitable for groundnut production. Such sites are best suited to lower-yielding *glaberrima* varieties. By planting a sativa variety (e.g. *samban konko*) on such sites, farmers run the risk of low rice yields if the rains are insufficient. However, this risk can be averted if *samban konko* is mixed with *disi kono*.

By intentionally mixing *O. sativa* and *O. glaberrima* rice types in this way, Susu farmers may be providing the conditions under which accidental fertilisation might occur across sterility barriers, giving rise to an intermediate rice type displaying characteristics of both *O. glaberrima* and *O. sativa*. Though cross-fertilisation is rare, such an intermediate type might be highly desirable, particularly if it displayed the sativa trait for high yield together with the *glaberrima's* stability in sub-optimal conditions. Rice breeders have, in the past, tried and failed to cross these species. Viable crosses have recently been made by Dr Monty Jones, a Sierra Leonean rice breeder currently on the staff of the West African Rice Development Association (WARDA) at Bouaké (Jones et al, 1997). Though it has yet to be verified, it is possible that farmers have unknowingly achieved what scientists have been trying to do for decades. ■

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