PEASANT RICE AGRICULTURE: ITS CHARACTER AND MECHANISMS OF GENETIC EROSION OF ITS GERMPLASM

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Abstract

Between 1986 and date, land races of rice (*Oryza sativa* Linn.) have been collected from rice-growing areas of Nigeria (Okposi in Abia state, Awgu in Enugu state, Ofada in Ogun state, Ijesa-Isu and Igbemo in Ekiti state, and Erinmo in Osun state) and they were characterized for their agronomic attributes.
Peasant rice holdings were studied for 4 years in Erinmo to elicit population dynamics of peasant rice germplasm. A model for the mechanism of erosion of genetic variability in the local germplasm of rice was constructed from this and earlier studies.
The factors implicated in the genetic erosion of peasant rice germplasm are; mode of harvesting, inherent population dynamics like choking up of late emergents, loss of lodging and shattering genotypes, loss of late-maturing genotypes, seed dormancy. Wholesale loss due to adoption of improved varieties and complete abandonment of rice farming are also important factor in genetic erosion of peasant rice agriculture.
These results suggest that conservation of rice local germplasm could be achieved through extensive survey, collection and characterization. Lack of encouragement of rice agriculture among peasants has contributed to the loss of genetic diversity in the landraces. This situation makes *in situ* conservation very difficult. It appears that peasant rice agriculture rather than large-scale agriculture will have a major role to play in our national food security programme for a long time.

1. Introduction

The term 'local germplasm' refers to the germplasm of rice used traditionally for agriculture before the advent of 'improved' varieties into the peasant farming system. They therefore necessarily include the germplasm of primitive rice crops ... the so called land races. In West Africa, local rice germplasm is a mixture of *Oryza sativa* L. which was introduced around 1500AD through various routes (Porteres, 1956; Nayer, 1973; Carpenter, 1978), *Oryza glaberrima* Steud, which is native to West Africa and occasional natural hybrids between the two species (Oka, 1991; Ng *et al.,* 1983). The term 'local germplasm' can also refer to indigenous wild rice -- *O. longistaminata* A. Chev. et Roehr, *O. punctata* Kotschy ex Steud. and *O. barthii* A. Chev., all of which are endemic in Nigeria.

There is a dearth of knowledge of the population dynamics, reproductive biology, species relationships and chromosome dynamics of these indigenous rice species except for limited investigations carried out by Olorode (1975), Faluyi (1985); Faluyi and Nwokeocha (1993). There is need to multiply these initial efforts so as to generate a viable baseline information on which a comprehensive rice improvement programme can be built. This work is restricted to the germplasm of peasant agriculture which, as already defined, consists of *Oryza sativa:* land races, some improved varieties, traces of *Oryza glaberrima* (Aladejana 2000) and hybrids among them. Peasant rice crop is grown essentially for subsistence rather than for commerce.

Faluyi and Nwokeocha (1993) examined germplasm collected from five rice-growing areas in Nigeria. They reported considerable variability involving undesirable agronomic attributes (difficult threshing, shattering, stem lodging, brown caryopsis, seed dormancy, late maturity etc.) and desirable one (early to medium maturity, dwarfness, heavy tillering, hardiness, long grains, heavy panicles, etc.) in local germplasm of rice. They attributed the variability of the local germplasm to the fact that farmers do not carry out conscious selections for agronomic traits. They suggested that the local germplasm will remain a reservoir of genetic resources because of this practice.

This major component of our genetic resource is being threatened by genetic erosion at two main levels:

(1) Peasant farmers are giving up local germplasm in preference for "improved" varieties which they do not have resources to maintain.

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(2) Natural selection operates in time, particularly against early maturers, very late maturers and cultivars that have residual seed dormancy in the local germplasm.

In this study, the mechanism of erosion of genetic variability in the local germplasm of peasant agriculture was investigated. This involved the survey of indigenous rice-growing areas in the southern part of Nigeria to determine the structure and character of the germplasm of peasant agriculture and collection of accessions of landraces of *O. sativa.*

2. Materials and Methods

This study site was located in the Erinmo-Omo Ijesa rice-growing community in Osun state. The specific site is at the foot of a range of hills along Ilesa – Akure road where some peasant farmers cultivate traditional upland rice.

Surveys were carried out for collection of genotypes from peasant holdings in the planting seasons of 1998 to 2002. Table 1 shows a list of the accessions used in this study. Collections were based on agrobotanical characteristics like maturity date, panicle form and number, grain shape and colour, japonica-indica forms and genetic attributes that have marker effects e.g. pigmentation of organs, shape and type of ligules etc. Collections were made off-and on-season. For on-season collections, basic botanical and agrobotanical data were taken *in situ* for preliminary characterization. All collections were characterized using the Rice Advisory Committee (1980) *Descriptors for Rice*.

An integral aspect of the methodology is the close contact with the farmers at land clearing, planting, bird scaring and harvesting to witness their cultural and husbandry procedures. Information elicited from the farmers include source of their planting material, germpalsm storage, the economics of production and the production hazards.

A sample of an enhanced germplasm DTPMFe$^+$ was made available to the cooperating farmer between 1998 and 2002. After 4 years of planting along with his local germplasm, purity was estimated as the proportion of the caryopsis of DTPMFe$^+$ that had brown caryopsis in a sample of 2000 caryopses.

3. Results

At the inception of this study in 1998, a survey of cultivated land races was carried out in Erinmo and Omo-Ijesha areas of Osun state where traditional upland rice cultivars are grown under slash-and-burn cultural practice. Population of the land races are genetically heterogeneous to varying degrees. Farmers acquired their seed stock over a long period and they retained seeds for next season planting from the bulk of their harvest in the previous season. This practice ensured that the genetic variability in the germplasm of peasant agriculture is preserved. The germplasm consists of indica, japonica and intermediate types with most of the indica grains coming from improved varieties which have polluted the land races over time. It also had a large proportion of brown caryopsis; indeed this proportion has been used in this work as an index of purity.

Table 1: Accessions used and their Distinguishing Characters

Accession	Collector/Source/Location	Ploidy level	Comment
ERINMO 9	Baderinwa, Omo-Ijesha 7° 38"N 4°45"E 2	2n = 24	upland rice from peasant farmer
ERINMO 6	"	"	upland, indica subspecies
ERINMO 7II	"	"	upland, indica, awned subspecies
ERINMO 5	"	"	upland japonica subspecies
ERINMO 15	"	"	upland, japonica intermediate subspecies
ERINMO 10	"	"	upland, indica awned subspecies
ERINMO 1	"	"	upland rice indica subspecies
ERINMO 14	"	"	upland rice, japonica subspecies
ERINMO 4	"	"	upland, awnless indica, subspecies
ERINMO 13	"	"	Upland rice japonica intermediate subspecies
OKPOSI III^A	Okposi, Abia State E°5"N 7° 29"E	"	Acyanic dwarf, indica awnless
OKPOSI III^B	"	"	Acyanic dwarf, indica awnless
OKPOSI II	"	"	Tall, pigmented
OKPOSI Pr^{++}	"	"	upland rice, intensive purple apiculus, tall, compact plant
DTPMFe$^+$	Faluyi Improved variety	2n = 24	Cultivated, new variety
OGIDE DWARF	Faluyi	2n = 24	Cultivated
TOS PURPLE	IITA 12°18"N 7°56"W	2n = 24	WARDA

Table 2: Aspects of the character of peasant rice Agriculture

	ASPECT	CHARACTER	COMMENT / REFERENCES
1.	Acquisition of germplasm	Germplasm acquired over a long period, seed stock for next season planting taken from bulk of harvest of previous season varieties acquired from unacertainable sources.	This is major source of conservation of genetic variability because no conscious selection is practiced
2.	Genetic composition of germplasm	Highly heterogenous --- indica, japonica, intermediate, open, compact plant types, brown, caryopsis, white caryopsis; long duration, improved varieties pollute the typical land race forms. Improved varieties were of early maturity, better yield; increase is through few tillers that are all productive	Proportion of brown caryopsis and grain shape scatter pattern are used as indices of genetic variability
3.	Cultural practices	Typical holding less than 1 acre, rarely bigger in one location, no fertilizer application; land allowed to fallow for about 2 or 3 years after each cultivation. Rice is not generally intercropped but maize and cassava were observed being used as border rows in the cause of this study. Harvesting is done once by clipping	Varieties are genetically eroded by the practice
4.	Intrinsic population dynamics of local germplasm	Stem lodging, shattering, dormancy and very early maturity, very late maturity are naturally selected against in the germplasm of peasant agriculture	Faluyi and Nwokeocha (1993) Baderinwa (2004)
5.	Purity check	An enhanced germplasm ($DTPMFe^{+}$) used as check, showed a brown caryopsis contermination of 0.46% over a 3 year period.	Contamination is due to the mode of acquisition as in 1; it could also be due to outcrossing Oziegbe (2004)
6.	Economics of production	Source of labour is the family, bird scaring is a major burden of production cost of input is minimal. As at 2003; a family could earn about (₦20,800:00) / acre apart from rice taken for feeding the family	Sale of rice is a major source of bulk in come
7.	Prospects	Peasant germplasm is a reserviour of genetic variability because of the entire culture of peasant rice farming (massive family labour input, the strain of bird scaring, low pricing due to low consumer acceptability, declining soil fertility, non-competitive advantage over other arable crops etc. have made rice farming unattractive. By the sixth year of this practice, co-operating farmers have abandoned rice farming	Abandonment of rice farming is a major source of genetic erosion.

Seed samples of DTPMFe^{+}, an enhanced germplasm, made available to the co-operating farmer at the inception of this study were assessed for purity after three years of planting. The level of contamination was assessed as a percentage of brown caryopsis. A contamination of 0.46% was determined. By 2000, Mr Ebire had abandoned his land races for an improved variety sold to him by some contractor who was probably not an Agricultural Extension Officer. By 2002, the man abandoned rice farming for the production of maize, yam and cassava because of the burden of rice production which made the returns less and less profitable.

The typical peasant rice farmer maintains a small holding which is generally less than one acre, rarely more, in one location. There is generally no fertilizer application but he does not overuse his farmland; the land is allowed to fallow for about two to three years after each cultivation. Bird scaring is a major burden of local rice production. It involves the entire family for some three weeks starting at the milk stage until harvesting. The method used are based on sound (drumming, rattling metals, firing dane guns, etc) and mechanical disturbance (throwing stones, using slings to project missiles) and other methods (scare crows, erecting line with video tape, charms). Rice is not generally intercropped but immediately after harvest, the land is prepared for late planting of maize and yam. Table 2 shows aspects of the character of peasant rice agriculture.

Figure 1 presents the model for the erosion of genetic variability in the local germplasm. This model is based on the population dynamics of the local rice germplasm monitored over the last eighteen years, the last four of which covered the period of this study. The pool of variability is maintained by the availability of plant forms–indica and japonica subspecies, the improved varieties and the hybrids among them, all of which co-exist on the peasant farms. The land races also contain various agrobotanical attributes like early, late and medium maturity; dwarf, tall and semi dwarf plants; white and brown caryopses; medium and long grains; and an attribute complex consisting of hardiness, dormancy, lodging, seed shattering; perennial and annual habit, low and heavy tillering, selection against which may contribute to genetic erosion in very subtle ways.

The sink shows the processes that can remove genotypes that are disadvantaged but not necessarily unfit from the pool of variability. Such processes are trangressive segregation leading to off types, lack of uniformity in maturity date, consumer preferences, lodging of plants, differential survival due to competition within plant population, adoption of 'improved' varieties some of which are of dubious origin and total abandonment of rice farming.

4. DISCUSSION

Genetic erosion occurs when a plant that has a set of valuable agrobotanical attributes is lost to the population. Faluyi and Nwokeocha (1993) reported that seedlings from dormant genotypes emerge later and they might get chocked up by seedlings of early-emerging genotypes; plants that lodge waste their seeds because they do not get harvested with the bulk of the population which is normally medium to late-maturing; early maturers and genotypes that shatter their seeds suffer a similar fate. The first collection undertaken in this work in 1998 was post-harvest on farmers' holding. This kind of collection is likely to have excluded early matures except those that have perennial ability.

The pool of variability in peasant rice gemplasm can be sustained by two major processes: continuous use of land races without any attempt at selection and hybridization followed by segregation. Faluyi and Nwokeocha (1993) documented the occurrence of intermediate types among the various populations of the local rice they studied. Cultivation of some improved cultivars along with land races is a common occurrence and this can also strengthen the pool of variability of peasant germplasm.

The process of genetic erosion could be classified into three major categories. The first has to do with the cultural practice of harvesting once in a population which is heterogeneous for practically all agrobotanical traits. This practice will exclude all early and late maturers which get wasted or are wasted by birds. Transgressive segregation from hybrids is likely to supply some genotypes which fall into those maturity date extremes into the gene pool but a good number of the segregants are likely to add to the gene pool. The practical solution to this problem is serial harvesting.

The second category is concerned with the dynamics in the population of rice. Their late emerging seedlings are usually choked up by the normal seedlings leading to the loss of their genetic resources. Faluyi and Nwokeocha (1993) identified genotypes that showed seed dormancy. IJ86B was one outstanding selection from the Ijesa-Isu population. Shattered seeds will suffer much the same fate because they do not get harvested. Materials in this category are selected against because they are unfit for survival in the population. These inherent population mechanisms therefore constitute natural selection for character states that are within acceptable values in time and space and against those that do not fall within acceptable values. The major strength of peasant germplasm is that it is not subjected to conscious selection. It therefore gets richer in terms of genetic variability with time.

The third category concerns major or wholesale loss of land races due to adoption of improved varieties.

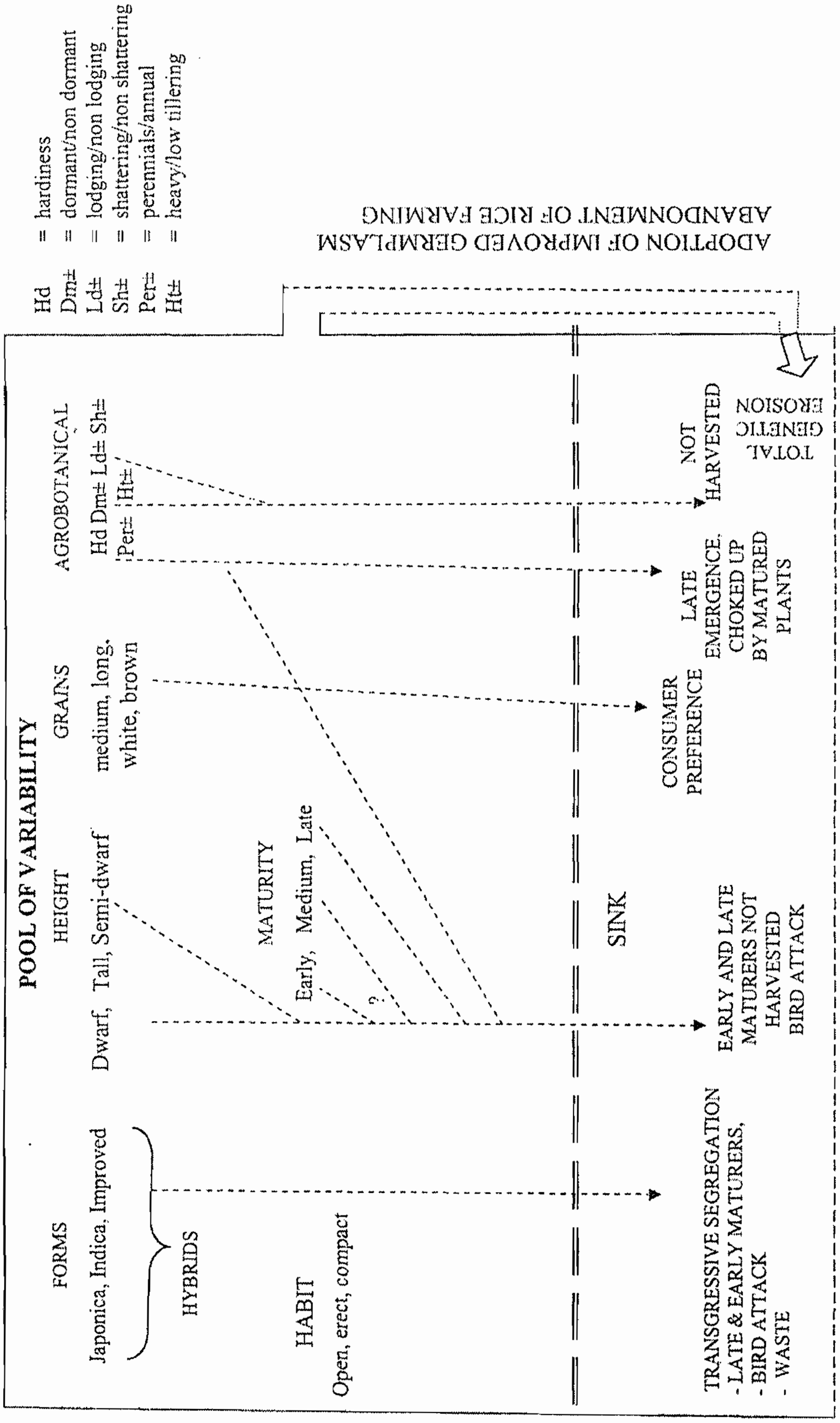

Fig. 1: Model for the mechanisms of erosion of genetic variability in the local germplasm of rice, *Oryza sativa*, Linn

This has been a major threat to the preservation of the genetic resources of peasant rice agriculture since the improved varieties offer more attraction because of consumer acceptability, high yield, early maturity and their potential for profit return. By 2002, the farmer who co-operated with the project had changed to an improved source of germplasm. The maturity date of his new variety was about 90 days and the plant yielded through many tillers bearing moderately dense panicles. By the end of 2002 planting season, the man abandoned rice farming for the production of arable crops.

The major threats to survival of local rice germplasm is wholesale adoption of improved varieties and abandonment of rice farming. These factors are the major constraints against *in situ* conservation which is the only means by which the potential for the conservation and promotion of further variability can be ensured. *Ex situ* conservation will certainly lose this vital advantage.

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