# International Journal of Botany

ISSN: 1811-9700

science alert

ANSInet
an open access publisher
http://ansinet.com

International Journal of Botany 5 (1): 112-115, 2009
ISSN 1811-9700


# Ratooning Potential of Interspecific NERICA Rice Varieties (*Oryza glaberrima*×*Oryza sativa*)

[1,2]K.A. Sanni, [2]D.K. Ojo, [2]M.A. Adebisi, [1]E.A. Somado, [2]O.J. Ariyo, [1]M. Sie, [1]I. Akintayo, [1]D.D. Tia, [1,2]S.A. Ogunbayo, [1]B. Cissé, [1]M. Sikirou and [2]M.A. Adekoya
[1]Africa Rice Center (WARDA), 01 BP 2031, Cotonou, Benin
[2]Department of Plant Breeding and Seed Technology,
University of Agriculture, Abeokuta, P.M.B. 2240, Abeokuta, Nigeria

**Abstract:** Field experiment was conducted in Deve (6°48 N, 1°47'E, 72 masl) in the Savannah zone of Benin Republic, to examine the increase in grain yield due to ratooning. Eighteen upland interspecific varieties (NERICA1-18) and their *Oryza glaberrima* (CG 14) and one of the *O. sativa* (WAB 56-104) parents were used in a Randomized complete block design with three replications. The first (main) crop was harvested at mass maturity, after which the tillers were hand mowed to stubbles of about 10 cm tall. These were then left without any further input, until the ratooned plants were ready for harvest. The result showed a large variation in the ratoon performance among NERICA, with ratoon ability ranging from 13% (NERICA 2) to 39% (NERICA 14 and 17). Total grain yield (main plus ratoon) was significantly different ($p<0.001$) from that of the main harvest. The maximum total grain yield was 6.14 t ha$^{-1}$ for NERICA 2 followed by NERICA 15 and 11 (6.02 and 6.01 t ha$^{-1}$, respectively). The yield increase of more than 1.5 t ha$^{-1}$ (the average yield of upland rice in Sub-saharan Africa) recorded in NERICA, with no additional input was very encouraging. This will presumably increase with additional input during ratoon. Therefore, NERICA rice is able to fructify twice, hence farmers can harvest more rice and make more profit.

**Key words:** Grain yield, NERICA, ratoon, rice, second harvest

## INTRODUCTION

Rice occupies a conspicuous position in the world's agro-based economy, being the most important food crop that provides nutrition for more people than any other crop. It accounts for 23% of the world's supply of calories (Brar and Khush, 2002). In Africa, rice has gradually become the main staple food crop of most countries (Malton *et al*., 1998). The production of rice in Africa does not meet this demand, therefore scientists are trying to fill the gap by developing high yielding cultivars that are highly resistant to insects and diseases and are adapted to various abiotic stresses in the continent, of which the New Rice for Africa (NERICA) was developed by Africa Rice Center (WARDA) and it's National Agricultural Research System (NARS) partners. Apart from developing high yielding varieties, techniques are needed that could also improve rice productivity.

Ratooning is the practice of obtaining a second harvest from tillers originating from the stubble of the previously harvested crop (main crop) (Jones and Snyder, 1987). It offers special scope for increasing rice production without expanding land area. Ratooning is a characteristic of rice and other members of the grass family (Graminae). When cut and exposed to the appropriate environment, the mother crop develops new sprouts with characteristics almost equal to its original form and capacities. The technology is widely used in the production of sugarcane, bananas and pineapples (Junelyn and de la Rosa, 2004).

The success of a good ratoon crop depends on the care with which the main crop is cultivated in the growing season. Agronomic practices and the care with which the main crop is protected against insect pests and diseases is a determining factor on how effective and efficient the ratooning will be (Rehman *et al*., 2007).

In irrigated areas, some residual moisture remains in the fields after the dry-season rice cropping, however, such moisture is usually not enough for a second crop even in an early maturing variety. The puddle soil conditions make it difficult to use this land for an upland crop, such as sorghum, after the dry-season crop (Bahar and De Datta, 1977).

**Corresponding Author:** Kayode A. Sanni, Africa Rice Center (WARDA), 01 BP 2031, Cotonou, Benin
Tel: (229)21350188 Fax: (229)213505 56

In rainfed areas, only one crop per year is generally grown. The moisture left in the field at the end of the wet season is often adequate for a second, short-duration crop, especially if the first crop is early maturing and the rainy season lasts about 6 months. However, the soil moisture may not be enough to permit high returns on investment in fertilizers and pesticides for another rice crop. Thus, a ratoon crop can be grown with about 50 to 60% less labor because no land preparation or planting is required and the crop matures with about 60% less water than the main rice crop (Elias, 1969). Ratooning of rice, should therefore be evaluated as a means of making the land productive after the dry-season crop in irrigated areas and after the rainy-season crop in rainfed areas (Bahar and De Datta, 1977).

Double harvesting systems has been used in the United States (Beachell and Evatt, 1960), Swaziland (Evans, 1957), India (Gupta and Mitra, 1948), Thailand and Taiwan (Iso, 1954), the Philippines (Parago, 1963) and China (Yang *et al*., 1958). Several studies have reported a high grain yield in the second crop in the tropics (Chauhan *et al*., 1985), in India (Reddy *et al*., 1979) and in Ethiopia (Prashar, 1970). This may be one practical way to increase productivity of rice per unit land in Sub-saharan Africa. The present study was to investigate the ratooning potential of the 18 named upland NERICA as a means of increasing rice grain yield in Africa.

## MATERIALS AND METHODS

The study was conducted on farmer's field at Deve village of Dogbo community situated at about 20 km from Lokossa in the Kouffo district in the Savanna zone of the Republic of Benin. The site is located on longitude 1° 47′E, latitude 6° 48′N and an altitude of 67 masl. The previous crop grown on the land was rice and this land has been used for rice cultivation over years by the farmers. The annual rainfall distribution in Deve is usually bimodal, with an average of about 1044 mm and a temperature range of 24.5 to 32.5°C. Rainfall commences in mid March and ends in early November with a mid-season dry period from mid July to mid August. The annual rainfall for the year 2006 was 1114.6 mm while the average monthly rainfall during the cropping season was 132.3 mm (Fig. 1).

The eighteen named interspecific (*Oryza glaberrima* ×*Oryza sativa*) NERICA (NERICAs 1-18) rice varieties and their *O. glaberrima* parent (CG 14) and one of the *O. sativa* parents (WAB56-104) were grown. The seeds were obtained from the genebank at the Genetic Resources Unit of WARDA, in Cotonou.

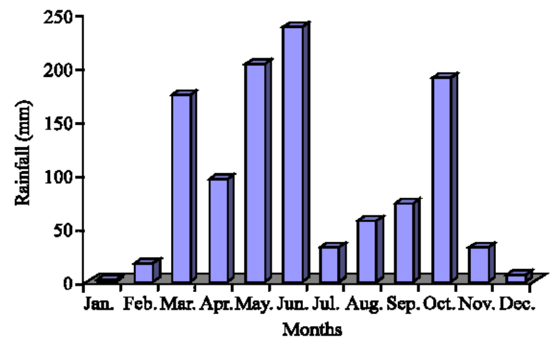


Fig. 1: Rainfall distribution pattern at Deve in 2006

The field experiment was carried out in 2006 between the month of July and November, in a randomised complete block design with three replicates. Seeds of each variety were directly seeded on a plot of 1×5 m at the rate of 2 plants per hill with spacing of 20 cm within plot and 40 cm between plots. Fertilizer rates used are NPK (10-18-18) as basal application at a rate of 100 kg ha$^{-1}$ during land preparation. Urea was applied at the rate of 65 kg ha$^{-1}$ as top-dressing first at tillering and a second time at booting. The plots were weeded regularly, to minimize weed infestation.

Soon after the first harvest, the tillers were hand mowed to stubble of about 10 cm tall. The plants were left without any further management practice, until they were ready for second harvest. The seeds from both harvests were dried to a moisture content of 12% and weighed.

**Data analysis:** Data collected were statistically analyzed with the General Linear Model (GLM) of the SAS program. The Least Significant Difference (LSD) was used for mean separation at 5% probability level.

## RESULTS

**Grain yield in the main harvest:** Significant differences ($p<0.05$) in yield were found among the cultivars in the main harvest (Table 1). NERICA 2 had the highest grain yield (5.42 t ha$^{-1}$), followed by NERICA 11, 6 and 18 with grain yield of 5.25, 4.88 and 4.45 t ha$^{-1}$, respectively. CG 14 had the lowest grain yield (1.83 t ha$^{-1}$) next to NERICA 3 (2.42 t ha$^{-1}$).

**Grain yield in the ratoon harvest:** There was a significant difference ($p<0.05$) in the ratoon grain yield among the varieties (Table 1). The highest ratoon grain yield was observed in NERICA 17 with yield of 1.58 t ha$^{-1}$, followed by NERICA 15 with yield of 1.53 t ha$^{-1}$. The ratoon yield in NERICA 18 and 14 were also high with their yields greater than 1 t ha$^{-1}$. The lowest ratoon yield was recorded in CG 14 (0.26 t ha$^{-1}$).

Table 1: Total grain yield, the first and ratoon grain yields of 20 rice varieties

| Varieties | Yield (t ha$^{-1}$) | | |
|---|---|---|---|
| | Main* | Ratoon* | Total* |
| NERICA2 | $5.42^{a}$ | $0.72^{cd}$ | $6.14^{a}$ |
| NERICA15 | $4.49^{c}$ | $1.53^{a}$ | $6.02^{ab}$ |
| NERICA11 | $5.25^{ab}$ | $0.76^{c}$ | $6.01^{ab}$ |
| NERICA6 | $4.88^{b}$ | $0.72^{cd}$ | $5.60^{c}$ |
| NERICA18 | $4.45^{c}$ | $1.13^{ab}$ | $5.58^{c}$ |
| NERICA17 | $4.00^{e}$ | $1.58^{a}$ | $5.58^{c}$ |
| NERICA13 | $4.58^{bc}$ | $0.92^{bc}$ | $5.50^{d}$ |
| NERICA1 | $4.08^{e}$ | $0.94^{bc}$ | $5.02^{e}$ |
| NERICA5 | $4.33^{d}$ | $0.66^{cd}$ | $5.00^{e}$ |
| NERICA9 | $3.92^{f}$ | $0.93^{bc}$ | $4.85^{f}$ |
| NERICA16 | $3.50^{h}$ | $0.99^{b}$ | $4.49^{g}$ |
| NERICA10 | $3.67^{g}$ | $0.74^{cd}$ | $4.40^{g}$ |
| WAB56-104 | $3.42^{hi}$ | $0.91^{bc}$ | $4.33^{gh}$ |
| NERICA8 | $3.58^{gh}$ | $0.68^{cd}$ | $4.27^{gh}$ |
| NERICA12 | $3.50^{h}$ | $0.71^{cd}$ | $4.21^{gh}$ |
| NERICA4 | $3.33^{i}$ | $0.80^{c}$ | $4.13^{gh}$ |
| NERICA14 | $2.83^{j}$ | $1.09^{ab}$ | $3.93^{h}$ |
| NERICA7 | $3.00^{ij}$ | $0.82^{c}$ | $3.82^{h}$ |
| NERICA3 | $2.42^{k}$ | $0.91^{bc}$ | $3.33^{i}$ |
| CG14 | $1.83^{l}$ | $0.26^{d}$ | $2.10^{j}$ |

*Means followed by the same letter(s) are not significantly different at the 5% level

**Total grain yield in double harvest:** The total grain yield which equals the sum of the main and the ratoon yield differed significantly ($p<0.05$) among the genotypes (Table 1). NERICA 2 had the highest yield of 6.14 t ha$^{-1}$ closely followed by NERICA 15 and 11 (6.02 and 6.01 t ha$^{-1}$ respectively). Other NERICA varieties such as NERICA 6, 18, 17 and 13 (with total grain yield of 5.60, 5.58, 5.58 and 5.50 t ha$^{-1}$, respectively) had their total grain yield significantly higher than the better parent. The lowest total yields (2.10 and 3.33 t ha$^{-1}$) were recorded for CG 14 and NERICA 3, respectively.

**Comparative ratoonability as a percentage of the main grain yield:** There was a large variation in the ratoonability among the NERICA varieties (Fig. 2). The ratoonability was significantly different among the NERICA and the parents. NERICA 14 and 17 had superior ratoonability of 39% each, followed by NERICA 3 with ratooning ability of 38%. NERICA 15, 16 and 7 with ratoonability of 34, 28 and 27%, respectively were of higher or equal ratoonability with the better parent WAB56-104 (27%). The lowest ratoonability was observed in NERICA 2 (13%), which was lower than that of CG 14 (14%) but not significantly different from it.

**Total grain yield in double harvests compared to one (main) harvest:** The yield varied largely according to variety and the harvest type ($p<0.001$) and was significantly affected by the interaction between the cultivar and the harvest type (Table 2). As expected, total

Table 2: Mean squares of the grain yield of rice varieties for different harvest types

| Source | df | NOVA SS | Mean square | Computed | FPr>F |
|---|---|---|---|---|---|
| Variety | 19 | 77.54 | 4.08 | 18.55 | 0.0001 |
| Harvest type | 2 | 510.54 | 255.27 | 1154.41 | 0.0001 |
| Variety* harvest type | 38 | 39.09 | 1.03 | 4.68 | 0.0001 |
| Block | 2 | 1.21 | 0.61 | 2.74 | 0.0683 |
| Error | 130 | 28.74 | 0.22 | | |
| Total | 191 | 657.12 | | | |

Table 3: Grain yield of twenty varieties of rice in two harvests

| Harvest type | Mean |
|---|---|
| Total harvest | $4.67^{a}$ |
| Main harvest | $3.77^{b}$ |
| Ratoon harvest | $0.91^{c}$ |

*Means followed by the different letter(s) are significantly different at 5% level

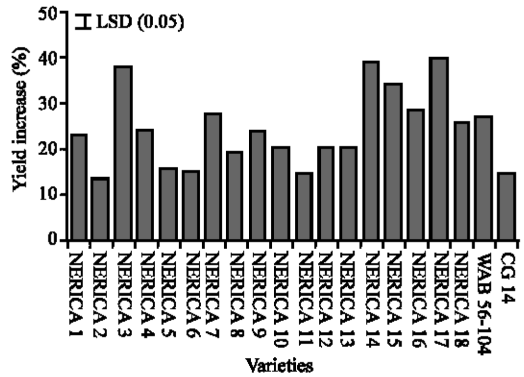


Fig. 2: Percentage increase in the yield of twenty varieties of rice due to ratooning

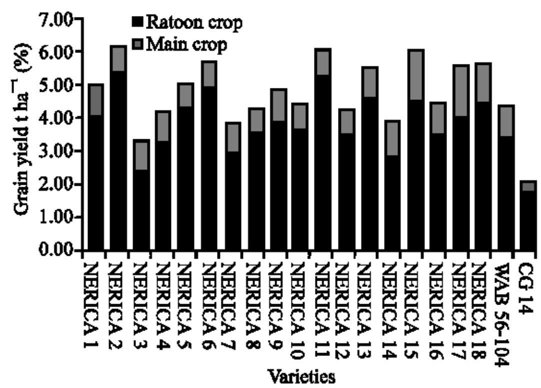


Fig. 3: Difference in the yield of twenty genotypes of rice due to ratooning

grain yield in two harvests was the highest, relative to the main and then the ratoon harvest (Table 3). The total yield from main and ratoon harvests was significantly ($p<0.05$) higher than the main yield in all the tested NERICA varieties (Fig. 3).

## DISCUSSION

A lot of information is available on ratooning in rice (Chauhan *et al*., 1985; Nakano and Morita, 2007), also, the prospect of increasing rice production in the tropics through ratooning (Bahar and De Datta, 1977). The present study indicated a large variation in ratoon performance among the 18 named rainfed upland NERICA, with the ratoon yield ranging from 0.66 to 1.58 t $ha^{-1}$, while the ratooning ability ranged from 13 to 39%. Although no additional fertilizer was applied to the ratooned crop, the yield in some of the NERICA varieties was increased to more than 6.0 t $ha^{-1}$. The ratoon grain yield were closer to the result gotten by Bahar and Datta (1976), when they evaluated six rice cultivars in Philippines. Also, similar findings on the ratoon yield potential of Interspecific progeny, including some NERICAs were reported in Kenya (Kouko *et al*., 2006). The wide variation recorded in yield suggests genetic divergence among the varieties, which could be exploited for breeding and management for ratooning ability. The ratoon-yield of more than 1.5 t $ha^{-1}$ (the average yield of upland rice in Sub-saharan Africa) in some of the NERICA varieties was very encouraging. Although the grain yield from the ratoon harvest was relatively lower than the main harvest, it however increased the total yield significantly at no extra cost, which implies more earning if applied by resource poor farmers. These results indicate that NERICA has a high potential grain yield in double harvesting.

## CONCLUSION

The results of this study provide a preliminary basis on the potentiality of using ratoon cropping in NERICA as a means of increasing rice yield in Africa. However, with addition of a little input such as fertilizer, to the ratooned crop, the yield may increase. There is therefore a need to study the mechanisms contributing to the ratoonability of these NERICA varieties, which was not investigated in this study.

## REFERENCES


Bahar, F.A. and S.K. De Datta, 1977. Prospects of increasing tropical rice production. Agron. J., 69: 536-540.

Beachell, H.M. and N.S. Evatt, 1960. Ratoon cropping of short season rice varieties in Texas. Int. Rice Commun. Newslett., 9: 1-4.

Brar, D.S. and G.S. Khush, 2002. Transferring Genes from Wild Species into Rice. In: Quantitative Genetics, Genomics and Plant Breeding, Kang, M.S. (Ed.). CAB International, Wallingford, UK., ISBN: 978-0851996011, pp: 197-217.

Chauhan, J.S., B.S. Vergara and F.S.S. Lopez, 1985. Rice ratooning. IRRI Res. Pap. Ser., 102: 19-19.

Elias, R.S., 1969. Rice production and minimal tillage. Outlook Agric., 6: 67-70.

Evans, L.J.C., 1957. Ratoon rice. World Crops, 9: 227-228.

Gupta, P.S. and A.K. Mitra, 1948. Possibilities of increasing the yield of rice by ratooning in the United Provinces. Indian Farming, 9: 13-15.

Iso, E., 1954. Ratoon culture of horai varieties. Rice and Crops in its Rotation in Subtropical Zones, Japan-FAO Association, Tokyo, pp: 197-200.

Jones, D.B. and G.H. Snyder, 1987. Seeding rate and row spacing effects on yield and Agron. J., 79: 627-629.

Junelyn, S. and de la Rosa, 2004. Harvest more rice with rationing. BAR Today,

Kouko, W.O., D. Makihara, J. Choke and P. Wakhu, 2006. NERICA research and promotion in Kenya. JICA Seminar on Sustainable Rice Farming in Africa. Dec. 6-8, Accra, Ghana.

Malton, P., T. Randolph and R. Guei, 1998. Impact of Rice Research in West Africa. In: Impact of Rice Research, Pingali, P.L. and M. Hossain, (Eds.). Thailand Development (IRRI), ISBN: 971-22-0106-6 Manila, Philippines, pp: 383-404.

Nakano, H. and S. Morita, 2007. Effects of twice harvesting on total dry matter yield of rice. Field Crops Res., 101: 269-275.

Parago, J.F., 1963. A review work on rice ratooning in the Philippines. Agric. Ind. Life, 25: 39-39.

Prashar, C.R.K., 1970. Some factors governing rice ratoon yield. Plant Soil, 32: 540-541.

Reddy, T.G., M. Mahadevappa and K.R. Kulkarni, 1979. Ratoon cropping of rainfed rice. Int. Rice Res. Newslett., 4: 25-26.

Rehman, H., M. Farooq and S.M.A. Basra, 2007. Rice Rationing: A Technology to Increase Production, 9th Internet Edn., DAWN-Business, Pakistan.

Yang, K.C., S.W. Sun and C.Y. Long, 1958. A study of regeneration rice. Acta Agric. Sin., 9: 107-133.