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# QUALITY EVALUATION OF RAINFED RICE (*Oryza sativa* L.) GENETIC RESOURCES

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**Proper evaluation of germplasm is a pre-requisite for its effecient utilization. A vigorous programme of evaluation of traditional cultivars and land races for yield, qualtiy and major biotic stresses has been underway since 1986 and many useful accessions were indentified. The present paper discusses the current status of quality evaluation programme. From 1988-96, three hundred and eighty four accessions were evaluated for 12 quality traits. In general, low variability (CV %) was recorded for hulling, milling recovery, volume expansion, amylose content, kernel breadth, cooked kernal length, and kernel linear elongation, Alkali value exhibited the highest variabilitity (CV 32 %) followed by rice recovery (21.5%). Variation for grain size (kernel length) and shape (L: B ratio) and water uptake was moderate (CV head-10-18%). The grouping of accessions is also presented. The potential accessions for various quality traits and accessions possessing multible desirable traits are also listed.**

Key words : *Oryza sativa* L, quality, rainfed rice, genetic resources

The constant updating of the cultivars is essentail to avoid genetic uniformity which may prove disastrous (Khoshoo, 1987). Crop genetic resources play a pivotal role in the cultivar development programme by continuosly providing new genes to evolve better varieties with high level of tolerance of major biotic and abiotic stresses and high crop yield and quality. In rice, considerably high genetic erosion had occured due to fast replacement of land races/traditional cultivars by high yielding varieties, which occupies nearly 74 per cent of the cropped area which could be even higher in irrigated areas. Still impressive land race diversity persists especially in stress environments such as rainfed agro-ecology and areas inhabited by the tribals and various ethnic groups. In view of such enormous genetic erosion, the collection and conservation programme at Central Rainfed Upland Rice Research Station has been intensified since 1985. The exploration and collection programme was reorganized systematically in a phased manner in collaboration with other institutes operating in the plateau region of Bihar and resulted in the collection/acquisition of 2091 accessions from the Bihar, adjoining areas of Uttar Pradesh, West Bengal and Orissa, IRRI, (Philippines) (Chauhan *et al*, 1995). The genetic potential of an accession remains unknown until it is systematically evaluated and screened; only then it may become an important gene source for utilization in the breeding programme. A vigorous programme of

evaluation of traditional cultivars and land races for yield and its components, quality and major biotic stresses has been underway since 1986 and several useful germplasm accessions have been identified (Varier *et al.*, 1990; Sinha *et al.*, 1990; Chauhan *et al.*, 1991; Shukla *et al.*, 1995; 1996). This paper presents the status of quality evaluation programme.

## MATERIALS AND METHODS

Three hundred eighty four accessions from diverse agro ecologies and origin were evaluated from 1988 to 1996 in the wet crop season (Table 1). They were grown in 3-row 3-5 plots; 3-5 in. long rows spaced 20 cm apart . The crop was raised at 40 N : 8.7 P : 16.6 K kg/ha. Except for rainfall, the other agronomic and plant protection practices were identical. A composite sample from the central row was used to record observations on brown rice colour, milled rice length, breadth and L : B ratio, hulling milling head-rice recovery, abdominal white, alkali value, amylose content; water uptake, volume expansion, cooked kernel length and kernel linear elongation.

**Table 1. Rice accessions evaluated for quality traits (1988-96).**

| Type | Accessions (Number) |
|---|---|
| **Indigenous upland** | |
| Traditional | 109 |
| Improved varieties | 42 |
| Improved breeding lines | 16 |
| Total | 167 |
| **Medium and low land** | |
| Traditional | 136 |
| Improved | 5 |
| Total | 141 |
| Total (Indigenous) | 308 |
| **Exotic upland** | |
| Traditional | 64 |
| Improved varieties/breeding lines | 5 |
| Total | 69 |
| **Medium and low lands** | |
| Traditional | 2 |
| Improved varieties/breeding lines | 5 |
| Total | 7 |
| Total (Exotic) | 76 |
| Grand Total | 384 |

Using Satake dehusker and Kett T-2 polisher, 100 g representative paddy sample was hulled and milled. Milling was done for 90 seconds. The method of Govindaswamy and Ghosh (1969) was followed to compute hulling, milling and head-rice recovery. Milled rice length and breadth were recorded by digital micrometer (Mitutoyo Japan). Standard methods were used to estimate alkali value (Little *et al.*, 1958) and amylose content (Juliano, 1971). The sample was cooked following the method of Beachell and Stansel (1963). Kernel linear elongation was computed as suggested by Azeez and Shafi (1966).

The range, mean and coefficient of variation (CV) were calculated to assess the variability for each character using standard statistical methods. The accessions were grouped by the frequency distribution for each character.

## RESULTS AND DISCUSSION

### Hulling, milling and head-rice recovery

The commercial success of the varieties is largely determined by the high hulling milling out-turn and head-rice recovery. Of these hulling and milling, recovery had very low variation (Table 2). The hulling and milling recovery ranged form 65.5 (Ambemohar, HRC 26) to 87.2 per cent (IRAT 240, HRC 1075) and 58.2 (Nagpur 22, HRCI 1) - 76.7 per cent (Gora Malti, NIC 105699), respectively. Similar results were reported by Chauhan *et al.*, (1991), and Malik *et al.*,

Table 2. Range, mean and coefficient of variation (CV) for quality characters in rice

| Character | Range | Mean Sem | CV(%) |
|---|---|---|---|
| Hulling recover (%) | 65.65-82.2 | 76.6±0.15 | 3.7 |
| Milling recovery (%) | 58.2-76.6 | 71.7±0.19 | 5.2 |
| Head-rice recovery (%) | 21.3-74.0 | 56.0±0.61 | 21.5 |
| Kernel length (mm) | 3.89-7.43 | 5.77±0.03 | 10.0 |
| Kernel breadth (mm) | 1.82-3.07 | 2.44±0.01 | 9.2 |
| L : B ratio | 1.68-3.91 | 2.38±0.02 | 14.3 |
| Alkali value | 2.50-7.00 | 4.00±0.07 | 32.0 |
| Amylose content (%) | 1.25-26.1 | 20.6±0.13 | 9.3 |
| Water uptake (ml) | 165.0-415.0 | 285.2±2.62 | 18.0 |
| Volume expansion | 3.5-4.3 | 3.9 ± 0.01 | 4.1 |
| Cooked kernel length (mm) | 7.0-12.4 | 9.85 ± 0.05 | 9.1 |
| Kernel linear elangation | 1.35-2.05 | 1.71 ± 0.01 | 6.1 |

(1994). Majority of the accessions (241) had hulling recovery between 75.1-80 per cent (Fig 1a). Nevertheless, 31 accessions (8.1%) had more than 80 per cent hulling recovery. The majority of the accessions showed total milling out-tum between 68.1-73.0 per cent followed by those having more than 73 per cent (Fig 1b). But the present collection showed substantial variation for head-rice recovery (CV 21.5%). The accessions were fairly well distributed for this trait (Fig 1c). A good number of accessions (44.8%) exhibited 60.1-70.0 per cent head-rice yield. Eight accessions had more than 70 per cent head rice recovery (Fig 1c). Accession BR 19-23 (HRC 680) had the lowest headrice recovery whereas, Shyamjeera (HRC 701), being the highest. Thus, there is a scope for improving this trait by selection. In earlier studies also similar results were reported (Chauhan *et al.*, 1991). Jennings *et al.*, (1979) also suggested that instead of total milled rice yield, emphasis should be given to improving head-rice yield because it varied more.

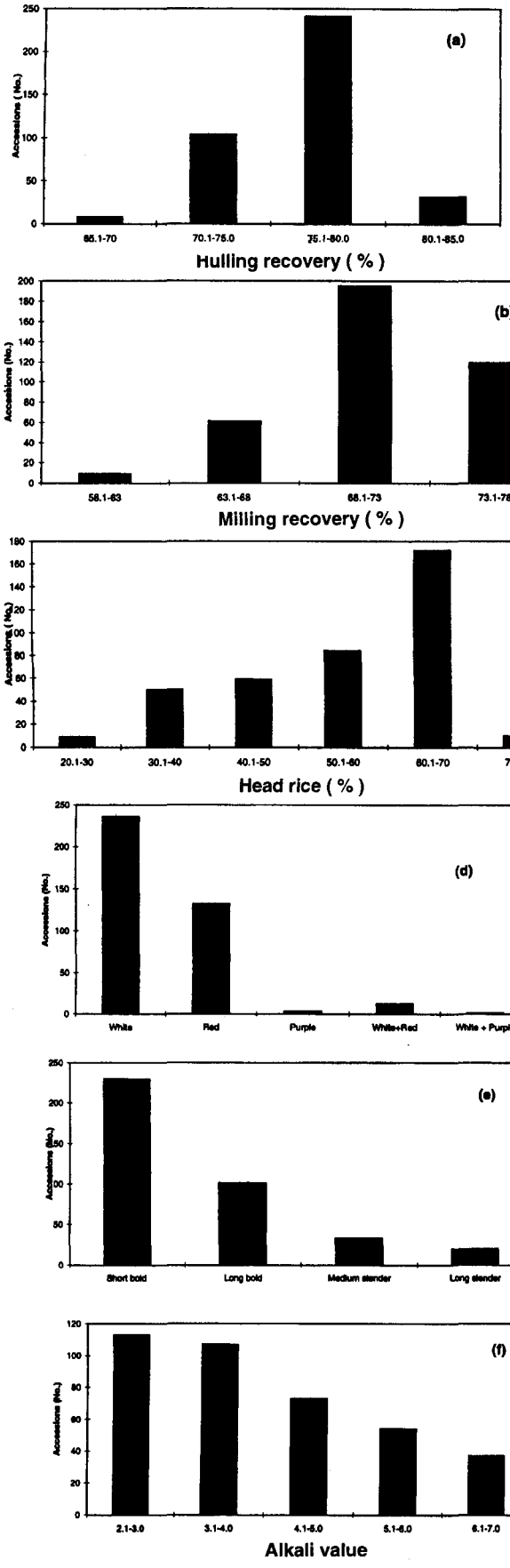
In the present collection, the environmental influence on head-rice recovery could not be ruled out fully as the accessions were evaluated in different seasons.

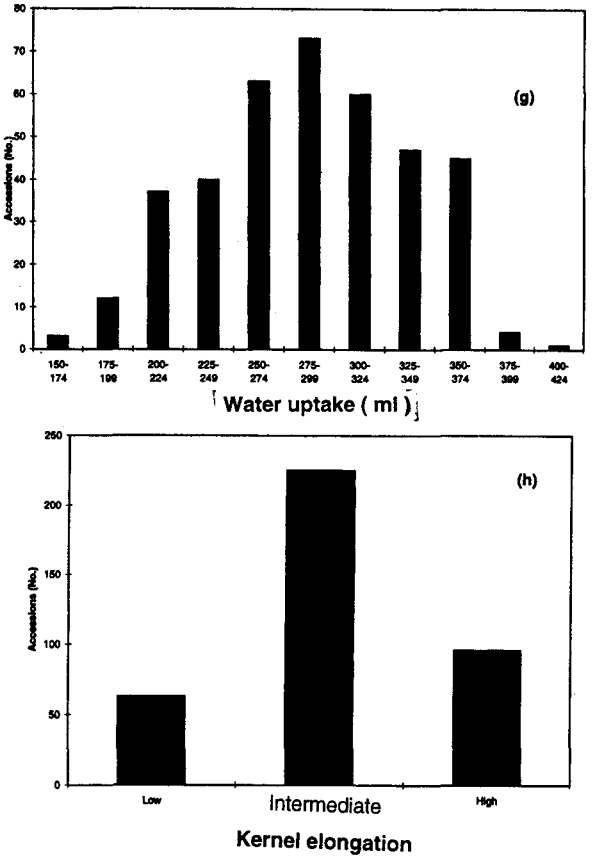
### Kernel colour, size and shape

These are the important accession identifying traits. Further, size and shape also determine the commercial value of the crop. Most of the accessions had white kernel (61.5%) followed by those with red (35.4%). Only 3 accessions showed purple colour (Fig 1d). Apart from accessions having distinct colours, 13 exhibited mixed colour. Probably these accessions were not selected for kernel colour and continued to grow as a mixed populations, as phenotypically there was no difference in their grain size and shape. The variation for kernel size and shape was moderate (Table 2). The range and mean for kernel length were 3.89 (Satalchini, NIC 105815)-7.43 mm (A 08-391, HRC 1003) and 5.78 ± 0.03, respectively. Accessions A08-391 (HRC 1003), CNA 5166 (HRC 1032), IRAT 144 (HRC 106 1), Kalamkata (HRC III 0) and Kalamdani (HRC 212) showed kernels as long as 7.0 mm or more (Table 3). The L : B ratio which determines the grading of rice varieties varied from 1.68 (Charamuni, HRC 467)-3.91 (Kalamkata, HRC 1110). (Table 2). The accessions showing the high L : B ratio are listed in Table 3. The accessions with narrow kernels are of the desired type because kernel breadth is negatively related to L:B ratio. Accession Kalamkata (HRC 1110) had the minimum kernel breadth (1.82 mm) and IRAT 115 (HRC 1058) the maximum (3.07 mm). Several accessions having narrow kernels were identified from the present collection (Table 3). Of the 384 accessions, 230 were short bold (59.9%), only 20 accessions (5.2%) had long slender grains (Fig 1e.).

### Chalkiness

The endosperm opacity or amount of chalkiness determines appearance of the milled kernel. Nevertheless, it does not affect eating or




nutritional quality but is important from the consumers point of view. The varieties with chalkiness have been reported prone to breakage during milling, hence varieties with clear endosperm are preferred. Only 41 accessions (10.8 %) had chalkeiness in kerenels, whereas 329 accessions (85.2%) showed clear endosperm. The rest showed occasional presence.

## Gelatinization temperature and amylose content

Starch is the principal constituent of the rice grain. The properties of starch as exemplified by gelatinzation temperature and amylose content are the major determinant of rice quality, especially cooking and eating. Therefore, choice of suitable donors with these two traits is the pre-requisite for the success of rice quality improvement programme. The premium quality rice of India-Basmati possess long slender and transluscent grains, intermediate amylose content (20-25 %) intermediate gelatinization temperature (5-6 alkali value) aroma and high kernel linear elongation.

**Table 3. Useful rice accessions for various quality traits for utilization in the hybridization**

| Character | Accessions |
|---|---|
| Hulling recovery ( 81.0%) | 63-83A (HRC 1001), Arroz - De Producto (HRC 1008), CNA 4744 (HRC 1027), IAC 025 (HRC 1044), IRAT 240 (HRC 1027) |
| Milling recovery ( 76.0%) | Arroz De Producto (HRC 1008), Gora Malti (NIC 105699), IRAT 233 (HRC 1027), CNA 5164 B (HRC 103 1), CNA 4125 (HRC 1020) |
| Head- rice recovery ( 70 %) | Shyamjeera (HRC 701), IRAT 115 (HRC 1058), Satalchini (NIC 105815), Gora Malti (NIC 105699), CNA 5164B (HRC 1031). |
| Kernel length ( 7.0 mm) | A 08-391 (HRC 1003), CNA 5166 (HRC 1032) IRAT 144 (HRC 1061), Kalamkata (HRC II 10) |
| Kernel breadth (1.98 mm) | Kalamkata (HRC 1110), Raskadam (HRC 29), Improved Raskadam (HRC 30), Delhi Sathi (HRC 453), Kalamdani (HRC 212), Kalamkadhi (NIC 105784) |
| L : B ratio ( 3.19) | Kalamkata (HRC 1110) |
| Intermediate alkali value (5-6) | Aditya (HRC 756),A08-391 (HRC 1003), Kalamdan (NIC 105814), Kadamkudhi (NIC 105791), Badnasall (NIC 105783) |
| Intermediate amylose content | Aus 454 (HRC 1013), Badshabhog (NIC 105510), ARC 7046 (HRC 432), Bagya (HRC 762), Black gora (HRC 362), Ajondholi (NIC 105703) |
| Intermediate amylose content and gelatinization temperature | Ambemohar (HRC26), Badshabhog (NIC105598and Bangani (NIC 105598), Black gora (HRC 370), Brown gora (HRC 371) |
| Water uptake (380ml) | Laloo 14 (HRC 457), Bhattadhan (HRC 19), Improved Raskadam (HRC 30), Sathi 34-36 (HRC 35), Shyamjeera (NIC 105806) |
| Volume expansion (4.2) | Tupijhinga (NIC 105719), White gora (HRC 303), Pathri (HRC 205), Kalamdani (HRC 212), IRAT 144 (HRC 1061) |
| Cooked kernel length (11.6mm) | Maghidhan (NIC 105752), Kalamdani (HRC 212), IRAT 240 (HRC 1075), IRAT 144 (HRC 1061), Brown gora (HRC 407) |
| Kernel linear elongation (1.94) | White gora (HRC 318), Sudha (HRC 432), Salumpikit (HRC 20), Marto (HRC 741), Deeptisall (NIC 105758) |

HRC Hazaribag Rice Collection Number, CRURRS, Hazaribag.
NIC National Indigenous Collection Number, NBPGR Base Centre, Ranchi.

Alkali digestion value gives an indication of gelatinization temperature. Alkali value ranged from 2.5 (ARC 11775, HRC 429) to 7.0 (ADT 33, HRC 766) and varied the most. Two hundred and twenty (57.3 %) accessions had high gelatinization temperature (1-3 alkali score). About 14.1 per cent of the accessions had intermediate gelatinizatiuon temperature (Fig If). A wide variation for this trait has also been reported earlier (Chauhan *et al.*, 1990; 1991). Of the 219 accessions analysed for amylose content, only Aditya and Neela, two rained upland varieties showed high amylose content (25%). Predominance of accessions (63.0%) with intermediate amylose content was observed in the present collection. Low amylose content ( %) was observed in 79 accessions. Thirty five accessions had the desirable combination of both intermediate gelatinization temperature (4.5-5.5 alkali score) and intermediate amylose content.The range for this character being 12.5 (IRAT 133, HRC 1059)-26.1 % (Aditya, HRC 756).

### Water uptake and volume of expansion

The basmati rices have high volume of expansion and water uptake. These two characters determine the cooking quality of rice. Fluffiness of cooked rice, is primarily due to water uptake and volume expansion. Water uptake exhibited considerable variation (CV 18%). Accession (Laloo 14) had the highest water uptake (415 ml). The accessions were fairly well distributed for this character (Fig 1g). Fifty accessions (13.0%) had the water uptake 350 ml. Two hundred and twenty eight accessions had less than 300 ml of water uptake. The accessions with high water uptake are listed in Table 3. Volume expansion did not show appreciable variation in this collection. The range being 3.5 (Raria, HRC 268)-4.3 (Pathri, HRC 205). In previous studies also, this character was observed to vary the least (Chauhan *et al.*, 1990; 1991).

**Table 4 : Characterization of rice accessions with multiple desirable quality traits**

| Accession | Hulling recovery (%) | Milling recovery (%) | Head rice recovery (%) | Kernel length (mm) | L:B ratio | Akali value | Amylose content (%) | Water uptake (ml) | Volume expansion | Kernel elongation |
|---|---|---|---|---|---|---|---|---|---|---|
| Kalamdani (HRC212) | 76.0 | 70.5 | 65.9 | 7.02 | 3.54 | 3.5 | 22.1 | 340 | 4.3 | 1.77 |
| A08-391 (HRC1003) | 80.0 | 74.8 | 66.0 | 7.43 | 2.80 | 5.5 | - | 370 | 4.0 | 1.48 |
| Arroz-De product (HRC1008) | 81.6 | 76.1 | 67.2 | 6.76 | 2.70 | 3.5 | - | 300 | 4.0 | 1.68 |
| CNA 5164 B (HRC 1031) | 81.6 | 76.1 | 70.7 | 6.37 | 2.19 | 2.5 | - | 230 | 4.0 | 1.63 |
| I RAT 144 (HRC 1061) | 79.6 | 74.1 | 68.3 | 7.13 | 2.55 | 3.5 | - | 225 | 4.2 | 1.63 |
| IRAT 233 (HRC 1072) | 81.7 | 76.3 | 53.4 | 6.48 | 2.39 | 5.5 | - | 265 | 4.0 | 1.66 |
| Kalamkata (HRC 1110) | 77.9 | 72.1 | 65.4 | 7.11 | 3.91 | 6.5 | 19.3 | 300 | 4.0 | 1.66 |
| Gora Malti (NIC 105699) | 80.0 | 76.7 | 72.8 | 5.52 | 2.41 | 6.5 | 19.8 | 305 | 3.7 | 1.77 |
| Kalamkadhi (NIC 105784) | 79.2 | 74.1 | 67.8 | 6.76 | 3.41 | 4.5 | - | 365 | 4.0 | 1.57 |

Underline values indicate desirable trait(s).

**Table 5. Characterization of rice accessions with a) high kernel elongation, b) intermediate amylose content and gelatinzation temperature**

| Accession | Hulling recovery (%) | Milling recovery (%) | Head rice recovery (%) | Kernel length (mm) | L: B ratio | Alkali value | Amylose content | Water uptake (ml) | Volume expansion | Kernel elongation |
|---|---|---|---|---|---|---|---|---|---|---|
| (a) Linear elongation | | | | | | | | | | |
| Salumpikit ( HRC 20) | 74.1 | 68.5 | 65.6 | 5.18 | 1.90 | 3.5 | 19.1 | 365 | 4.0 | 2.05 |
| Whitegora ( HRC 318) | 76.3 | 70.7 | 40.0 | 5.03 | 1.72 | 3.1 | 21.5 | 295 | 4.0 | 1.95 |
| Sudha (HRC 432) | 77.3 | 72.6 | 66.4 | 5.32 | 2.08 | 5.5 | 21.5 | 330 | 4.0 | 2.03 |
| Marto (HRC 741) | 79.8 | 74.0 | 63.5 | 5.06 | 2.05 | 6.5 | 21.0 | 295 | 3.7 | 1.94 |
| Deeptisall (NIC 105758) | 78.0 | 72.5 | 68.0 | 5.10 | 1.90 | 4.5 | 360 | 4.0 | 1.96 | |
| (b) Intermediate amylose content and gelatinization temperature | | | | | | | | | | |
| Birsadhan 201 ( HRC751) | 77.0 | 68.5 | 58.0 | 5.49 | 2.06 | 4.5 | 21.7 | 265 | 4.0 | 1.86 |
| Browngora (HRC 379) | 80.1 | 75.2 | 56.4 | 5.41 | 2.05 | 5.5 | 21.5 | 220 | 4.0 | 1.81 |
| Chaingora (NIC105534) | 78.5 | 71.0 | 55.0 | 5.23 | 2.00 | 4.5 | 23.0 | 280 | 4.0 | 1.80 |
| Jhilidhan (HRC 703) | 80.0 | 75.0 | 68.3 | 6.09 | 3.01 | 4.5 | 21.0 | 280 | 4.0 | 1.84 |
| Prakash (HRC 87) | 73.0 | 68.8 | 43.3 | 5.17 | 2.23 | 4.5 | 20.5 | 315 | 3.7 | 1.93 |
| Marto ( HRC 741) | 79.8 | 74.0 | 63.5 | 5.06 | 2.05 | 6.5 | 21.0 | 295 | 3.7 | 1.94 |

Underined values indicate desirable trait (s).

## Kernel elongation

This is the most prized character in the high quality rice besides aroma. Cooked kernel length varied from 7.0 (Raskadam, HRC 29)-12.4 mm (Kalamdani, HRC 212) and exhibited low variability (Table 2). The average length was 9.85 + 0.05 mm. Kernel linear elongation although showed a wider range of 1.35 (Gaharadhan, HRC 1106) 2.05 (Salumpikit, HRC 20) but the character did not vary much (CV 6.1%). Most

of the accessions (225; 58.6 %) exhibited intermediate linear elongation (1.62 - 1.77). Ninty nine accessions showed high (1.77) kernal linear elongation (Fig 1h). Several potential accessions with multifile desirable quality traits were identified and characterized (Tables 4 and 5) among this collection for utilization in the quality improvement of rice.

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