

Improvement of Local Speciality Rices as a Boon to Health, Wealth and Export Diversity: Case of Kalanamak Rice

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Abstract

A blessing from Lord Buddha some 3,000 years ago, and now a heritage rice of Uttar Pradesh, India is valued for its aroma, taste and nutritive quality. Its cultivation declined from 50,000 ha to less than 2,000 ha and was at the verge of extinction. No attention was paid for improving Kalanamak and it survived as landrace due to the mercy of the farmers. PRDF collected, catalogued and conserved 250 accessions of Kalanamak, and the best one, through Pureline selection, was released in 2007 and notified in 2010 as KN 3. Mutation breeding using gamma rays and EMS gave many academically interesting mutants but no high yielding dwarfs. Hybridization of KN 3 with Swarna Sub1 and Improved Sambha Mahsuri yielded varieties like Bauna Kalanamak 101, Bauna Kalanamak 102 and Kalanamak with shorter duration and 50% higher yield, released and notified in years 2016, 2017 and 2019 respectively. Protocol for organic production with higher yield was developed and certification under PGS arranged. Kalanamak is sugar-free with 49 to 52% Glycemic Index, 11% protein, 3 times higher Iron and 4 times higher Zinc. It is unique rice to have Vitamin A in form of Beta Carotene. Kalanamak is backed by Geographical Indication and PPV&FRA, and selling at five times higher price of common rice tripling farmers' income. Now exported to Singapore, Nepal and Dubai has opened door to prosperity and added diversity to Basmati for export. This success story can be repeated for other land rices of speciality status.

Keywords: Aroma, Mutation Breeding, Glycemic index, export, farmers income, Organic

Introduction

Kalanamak rice variety is an epitome of best aromatic rice cultivated and consumed in North-eastern part of Uttar Pradesh (Chaudhary and Tran, 2001). Locally, this heritage rice is even classed superior to Indian mystic rice Basmati. However, over centuries of cultivation and farmers' way of handling seed, neglect by research institutions and double onslaught on economic front by High Yielding Varieties (HYV), its area reduced from 50,000 ha to less than 2,000 ha (Table 1). Deterioration in "grain quality" and loss of aroma happened due to spontaneous mutation and out-crossing, non-scientific seed production and cultivation, in changed environment and processing practices. However, by continued researches done at Participatory Rural Development Foundation (PRDF) during 1998 to 2021, varieties and technologies were developed to save Kalanamak and revert to old glory. Exact history of its cultivation is not recorded but it is believed

that Kalanamak was given to farmers of Bajaha jungle in Siddharthnagar district of Uttar Pradesh some 3,000 years back (Chaudhary and Tran, 2001) by Lord buddha.

Materials and Methods

We collected 250 germplasm accessions of Kalanamak rice and the Accession No. 3 was handled by Pureline selection method of breeding and released as KN3. It was crossed with Swarna Sub₁ and segregating generations handled through pedigree method of breeding to develop semi-dwarf variety Bauna Kalanamak 101. KN3 was also crossed with Improved Sambha Mahsuri to develop variety Bauna Kalanamak 102. Variety Kalanamak Kiran was developed from the cross KN3 x Swarna Sub₁ and notified in 2019 as Kalanamak Kiran by the Central Variety Release and Notification Committee of Government of India. These varieties were tested multi-location by the AICRIP trials in whole country and at RATDS by Department of Agriculture



in U. P. Grain qualities were tested at NRR I Cuttack, ICAR-IIRR Hyderabad, IICT Hyderabad and R-FRAC, Lucknow.

Organic Protocol on KN3 variety was developed with inputs like green manure, poultry manure, Bhumi Shakti, FYM, *Trichoderma*, *Pseudomonas*, Herbozyme, Amrit Pani, Decomposer in various combinations. Multi-location trials were conducted in Gorakhpur, Mahrajganj and Siddharthnagar districts of U. P. The best combinations were recommended to produce Organic Kalanamak Rice. Participatory Guarantee System (PGS) of the NCONF, Ghaziabad was used to certify the product as “PGS India Green” and “PGS India Organic”.

Results and Discussion

Initial research to improve Kalanamak

Initial research on Kalanamak started with the collection of its germplasm (Chaudhary *et al.*, 2010; Chaudhary and Mishra 2010) and mutation breeding (Chaudhary, 1979). Using 42 morpho-agronomic characters, accessions were described, catalogued (Chaudhary *et al.*, 2010), and the collection was deposited in the National Gene Bank at ICAR- NBPGR New Delhi (Chaudhary, 2005; Chaudhary *et al.*, 2010; Chaudhary, 2016). The mutants were mostly of academic nature (Chaudhary and Chauhan, 1979; Mishra and Chaudhary, 2011) but none were found superior to existing varieties (Chaudhary *et al.*, 2012).

Purification and release of first Kalanamak variety

U. P. Council of Agricultural Research (UPCAR) financed extensive collection of Kalanamak from all possible sources. These sources included National Gene Bank of NBPGR, New Delhi; N. D. University of Agriculture and Technology, Faizabad; Central Rice Research Institute Cuttack, and farmers of North-Eastern U. P. PRDF tested 250 collections to find out that some of the collections were non-aromatic although the grain appearance was identical to aromatic Kalanamak accessions. Some accessions had mixtures of scented and non-scented Kalanamak in various proportions. One of the pureline selections developed from the collection of Siddharth Nagar district was tested as KN3-27-3-3 and released by U. P. State Variety Release Sub-Committee and notified by the Central Variety Release Committee in 2010 as KN 3 (Chaudhary, 2009). Due testing was done at Regional Agricultural Technology Demonstration and Testing Station (RATDS) of U. P.

Development and Release of Bauna Kalanamak 101

Bauna Kalanamak 101 was developed out of a cross Kalanamak KN 3 with Swarna Sub₁ and tested as UPCAR-KN-2-19-14-1-1. PRDF had proposed a number of semi-dwarf breeding lines of Kalanamak for testing at RATDS during the years 2012 to 2015 in state trial called “Paddy Standard Varietal Trial: local aromatic, irrigated”. The average yield superiority of UPCAR-KN-2-19-14 was 46.41 over its check Kalanamak KN3. The State Variety Release Sub-Committee released it in 2016. The Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops approved in its 75th meeting and notified it in its Gazette No. 3-51/2016-SD.IV dated 23rd December 2016 with the name “Bauna Kalanamak 101”.

Development and Release of Bauna Kalanamak 102

Bauna Kalanamak 102 was developed out of a cross Kalanamak KN 3 with Improved Sambha Mahsuri and tested as UPCAR-KN-1-5-1-1-1 at RATDS of Department of Agriculture U. P. during 2012, 2013 and 2014. It was released and notified during the year 2016 as Bauna Kalanamak 102. With plant height of 95cm, it is non-lodging and suitable for combine harvesting. Based on the overall test, the test entry UPCAR-KN-1-5-1 (Bauna Kalanamak 102) yielded 32.37 quintal / ha. That way it out-yielded the check variety Kalanamak KN3 by 30.37%. It is 10 day early in maturity than Kalanamak KN3. In AICRIP trials conducted by Indian Institute of Rice Research (ICAR - IIRR), Hyderabad in Kharif 2014, the mean yield was 3198 kg/ha as against 2792 of Kalanamak KN3, and flowering duration earlier by 11 days across India. In the year 2017 it was released by U. P. State Variety Release Committee of Department of Agriculture, and notified by Government of India as “Bauna Kalanamak 102” (Chaudhary *et al.*, 2018).

Development and Release of Kalanamak Kiran

Selected out of cross of Kalanamak KN3 and Swarna Sub₁, it was tested at RATDS of Department of Agriculture as PRDF-2-14-10 (Kalanamak Kiran), was tested at RATDS during 2013 – 2016. It stood at first rank with average yield of 32.95 quintal / ha. It out-yielded the check variety Kalanamak KN3 by 26.58 %. Its aroma content was confirmed by the Indian Institute of Chemical Technology (IICT), Hyderabad confirmed its aroma equal to KN3. It is

semi-dwarf, lodging resistant and suitable for harvesting by combine harvester (**Table 1**). Bauna Kalanamak 102 has the same level of Iron and Zinc as its original parent

Kalanamak It was notified by the Government of India Gazette of India under Gazette No. 3220 (Part II (3) dated 06 08.2019.

Table 1. Area (estimate of PRDF) during 1960 to 2021 under Kalanamak varieties in 11 districts covered under Geographical Indications (GI)

Sl. No.	Year	Estimated Area (ha) of Kalanamak	Remark on technologies
1	1960	50,000	Traditional area under Kalanamak
2	1970	40,000	Traditional area under Kalanamak
3	1980	10,000	Spread of HYV rice
4	1990	2,000	Spread of HYV rice
5	2000	2,000	Spread of HYV rice
6	2010	3,000	Notification of Kalanamak KN3
7	2015	10,000	Demonstration of Kalanamak KN3
8	2016	20,000	Notification of Bauna Kalanamak 101
9	2017	25,000	Notification of Bauna Kalanamak 102
10	2018	35,000	Release of Kalanamak Kiran
11	2019	40,000	Notification of Kalanamak Kiran
12	2020	45,000	Notification of Kalanamak Kiran
13	2021	50,000	Notification of Kalanamak Kiran, Govt support for publicity, exhibition and marketing
14	2022	70,000	Support from government, consumers and traders to the available technologies.

Protocol for Organic Production of Kalanamak

Protocol for producing organic Kalanamak rice was developed based on the multi-location and multi-year trial. A manual was prepared for farmers (Chaudhary and Mishra, 2016). Using *Trichoderma* and *Pseudomonas* in combination showed synergistic effect and increased the yield. Additional treatments with green manure, BGA, PSB were added for farmers of different area. Plant protection measures using Waste Decomposer, *Amrit Paani* etc were also perfected. Gorakhpur and four other districts have been selected under the Organic Crop Production scheme under *Paramaparagat Krishi Vikas Yojna* (PKVY). PRDF as the Regional Council of National Centre of Organic Farming (NOF) Ghaziabad of the Ministry of Agriculture and Farmers Welfare certifies it under Participatory Guarantee System (PGS) system and give labels of “PGS- INDIA - GREEN” and “PGS- INDIA - ORGANIC” categories.

Morpho-agronomic Characters and Cultivation practice

Kalanamak is highly photoperiod sensitive variety with short basic vegetative phase. It heads during mid October. Morpho-agronomic characters and grain quality characters of Kalanamak make it very suitable for production and consumption. Kalanamak should be produced only during Kharif season in its Geographic Indication area of 11 districts U. P. to maintain its grain quality. It should be cultivated like any other HYV but best is Organic Production techniques. Sheath blight and grain sucking pests need to be controlled using appropriate methods.

Grain quality

Kalanamak has Medium Slender grain. These have very high (70%) head rice recovery. Due to 19 – 20% amylose, cooked rice of Kalanamak remains soft and has excellent



grain elongation (**Table 2**). In all India testing under AICRP, coordinated by Indian Institute of Rice Research (ICAR-IIRR), Hyderabad it was found to have all favourable grain quality characters (Table 3). Kalanamak varieties have the highest level of Iron and Zinc combined. Due to this

reason, Kalanamak was the only rice variety from north India included in the **NutriFarm** Project of the centre and state of U. P. Kalanamak is the most nutritious of all rices in terms of protein, iron, zinc, Vitamin A as Beta Carotene (Chaudhary *et al.*, 2021) while being sugar free (**Table 2**).

Table 2. Grain quality characters of Kalanamak KN 3, Bauna Kalanamak 101, Bauna Kalanamak 102 and Kalanamak Kiran rice varieties (analysed at NRRRI Cuttack, NDUAT Ayodhyay, ICAR-IIRR Hyderabad and IICT Hyderabad, and R-FRAC, Lucknow).

Sl. No.	Traits	Description of the variety			
		Kalanamak KN3	Bauna Kalanamak 101	Bauna Kalanamak 102	Kalanamak Kiran
1	Kernel length	5.76 mm	5.76 mm	5.76 mm	5.76 mm
2	Kernel width	2.18 mm	2.18 mm	2.18 mm	2.18 mm
3	L/B Ratio	2.64 mm	2.64 mm	2.64 mm	2.64 mm
4	Grain type	Medium slender	Medium slender	Medium slender	Medium slender
5	Kernel colour	White	White	White	White
6	1,000 grain weight	15 grams	15 grams	15 grams	15 grams
8	Hulling	80 %	80 %	80 %	80 %
9	Milling	75 %	75 %	75 %	75 %
10	Head rice	70 %	70 %	70 %	70 %
11	Alkali value	6 - 7	6 - 7	6 - 7	6 - 7
12	Volume Expansion Ratio	4.5	4.5	4.5	4.5
13	Gel consistency	80 mm	80 mm	80 mm	80 mm
14	Amylose content	21 %	22 %	22 %	21 %
15	Aroma	Highly aromatic	Aromatic	Highly aromatic	Highly aromatic
16	Iron (ppm) *	4.82	4.35	4.55	4.81
17	Zinc (ppm)*	16.97	14.35	14.55	16.37
18	Protein	10.64 %	10.50 %	10.64 %	10.64 %
18	Beta Carotene**	0.42 mg/100g	0.40 mg/100g	0.42 mg/100g	0.42 mg/100g

* All India average of 15 locations from AICRIP trials

** Analysis done at R-FRAC, Dept. of Horticulture, Govt. of U. P., Lucknow

Economics and Tripling Farmers' Income

Due to poor yield, poor quality and lesser income as compared to HYV rice, area under Kalanamak had declined before 2000. However, now with the availability of better quality varieties, those negatives have been annulled. Minimum Support Price (MSP) for fine paddy is around Rs. 2,000/ qtl but Kalanamak sells for Rs. 4,500/- and rice as high as Rs. ,35,000/- per quintal. It is being exported adding diversity to lone Basmati from India. Common slogan that "Basmati for your eyes and Kalanamak for your palate" is popular in eastern U. P.

Conclusion

Improved varieties of Kalanamak rice namely KN3, Bauna Kalanamak 101, Bauna Kalanamak 102 and Kalanamak Kiran have been developed notified. Nucleus, Breeder, Foundation and Certified seeds of these varieties are available. Package of practices to produce common and organic Kalanamak rice been perfected. Hundreds of farmers are linked with the local and export markets on attractive terms for sales on long-term basis. Summarily, compared to Rs. 43,100 / ha net profit from common HYV rice, Kalanamak KN3 gives Rs. 69,375, Bauna Kalanamak

Rs. 126,250 and Organic Bauna Kalanamak Rs. 1,38,000 net profit per hectare. Consumers are assured of quality. Other local germplasm with speciality status can repeat the same story of Kalanamak.

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