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Breakthrough in Improving Farmers' Income Sustainably by producing Kalanamak Rice

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ABSTRACT

Kalanamak is heritage rice of eastern Uttar Pradesh and valued for its aroma, taste and nutritive quality. Its cultivation declined from 50,000 ha to less than 2,000 ha due to varietal deterioration and competition from HYV. Four improved varieties, KN3, Bauna Kalanamak 101, Bauna Kalanamak 102 and Kalanamak Kiran were released in 2010, 2016, 2017and 2018 respectively. Last three varieties yield 50% more than traditional Kalanamak KN3 and mature 10 days earlier. Normal selling price of the Kalanamak paddy ranges between Rs. 2500/- to Rs. 3500/- per quintal. In spite of MSP announced by the governments, most farmers sell their HYV paddy around Rs. 1300/- per quintal. Cost of cultivation of Kalanamak and yield the same as HYV now, farmers get three times more net profit. Organic Kalanamak fetches 20% premium over normal Kalanamak. Summarily compared to Rs. 17,500/- ha net profit from common HYV rice, Kalanamak KN3 will give Rs. 44,375, Bauna Kalanamak Rs. 71,500 and Organic Kalanamak Rs. 92,500 per hectare net profit. With the PRDF arranged contract growing, by involving farmers and marketing companies from Kharif 2018, tripling the net profit of the farmers is assured sustainably. Thus, the proverb "Paddy and Poverty go together" is a myth now.

KEYWORD

Kalanamak rice, tripling farmers' income, organic production, market linkage

INTRODUCTION

Rice is one of the important cereals crop mainly grown in kharif season and play very significant role in Indian food security (Singh *et al.*, 2017). Kalanamak rice variety is an epitome of best aromatic rice cultivated and consumed in Northeastern part of Uttar Pradesh (Chaudhary and Tran, 2001). To the local palate, it was even classed superior to Indian mystery rice Basmati. However, over centuries of cultivation and farmers' way of handling seed, neglect by rice research institutions and double onslaught on economic front by High Yielding Varieties (HYV), its area went down from 50,000 ha to less than 2,000 ha during 1990 and 2000 again rebound up to 35000 ha during 2018 (Table 1).

Reported grain "quality" deterioration and loss of aroma was discovered due to a gamut of reasons starting from spontaneous mutation and out-crossing that resulted into mixtures of aromatic and non-aromatic types, non-scientific seed production and altered cultivation and processing practices. However, by continued researches, funded by U. P. Council of Agricultural Research (UPCAR) during 2001 to 2008, done at Participatory Rural Development Foundation (PRDF) technologies was developed to save Kalanamak and hope to bring its old glory back. Kalanamak variety of rice has been under cultivation since time immemorial. Exact history of its cultivation is not recorded but it is believed that Kalanamak was a preferred variety for offerings given to Lord Buddha some three thousand years ago (Chaudhary and Tran, 2001). Kalanamak has been in cultivation mainly in Northeastern part of Uttar Pradesh and western and central part of Nepal Tarai. Over a period of a few thousand years under cultivation and with no system of scientific seed production, there has been rapid decline in its grain quality. Many voices were raised for its declining grain quality and reducing area but nothing concrete was done to improve the situation by any research institution.

MATERIALS AND METHODS

The material for the study comprised of four released and notified varieties of Kalanamak namely Kalanamak KN3, Bauna Kalanamak 101 and Bauna Kalanamak 102. Kalanamak KN3 was developed out of a large germplasm collection of more than 150 accessions of Kalanamak collected by PRDF. Bauna Kalanamak 101 and Bauna Kalanamak 102 were developed through hybridization of KN3 Swarna Sub_1 and Improved Sambha Mahsuri respectively. Kalanamak Kiran was also developed through hybridization of KN 3 and Swarna Sub_1 followed by pedigree selection. The Certified Seeds of these were provided to the farmers in Basti, Deoria, Gorakhpur, Kushinagar, Mahrajganaj, Sant Kabir Nagar and Siddharth Nagar districts. Each demo plots or experiments were conducted in one acre plots.

Organic protocol for the production of Organic Kalanamak rice was developed using various known inputs from organic Kalanamak. Green Manure, Bhumishakti, Herbozyme, FYM, Poultry dropping, Trichoderma, Pseudomonas and Neem-based pesticides were used for raising the crop. Trial was laid out in Randomised Complete Block Design at three locations in Gorakhpur, Mahrajganj and Siddharth Nagar districts. Grain quality analyses were performed at NDUAT Faizabad, and Indian Institute of Chemical Technology, Hyderabad. Cost benefit

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Table 1: Area (estimate of PRDF) during 1960 to 2017 under Kalanamak varieties in 11 districts covered under Geographical Indicator (GI)

Year	Total Area (ha) of Kalanamak	Remark on technologies
1960	50,000	Traditional area under Kalanamak
1970	40,000	Traditional area under Kalanamak
1980	10,000	Spread of HYV rice
1990	2,000	Spread of HYV rice
2000	2,000	Spread of HYV rice
2010	3,000	Notification of Kalanamak KN3
2015	10,000	Demonstration of Kalanamak KN3
2016	20,000	Notification of Bauna Kalanamak 101
2017	25,000	Notification of Bauna Kalanamak 102
2018	35,000	Release of Kalanamak Kiran

were calculated taking actual data from a number of farmers using survey methods.

RESULTS AND DISCUSSION

Initial research to improve Kalanamak

Initial research on Kalanamak started with the collection of its germplasm and mutation breeding (Nanda *et al.*, 1974). Using 42 morpho-agronomic characters, accession was described and catalogue was prepared and the entire collection was deposited in the National Gene Bank at NBPGR New Delhi. The mutants were mostly of academic nature (Mishra and Chaudhary, 2011) but few were tested in yield trials but none were found superior to existing varieties (Chaudhary *et al.*, 2012).

Purification and release of first Kalanamak variety

PRDF in Gorakhpur, under two projects financed by U. P. Council of Agricultural Research (UPCAR) has made extensive collection of Kalanamak from all possible sources. These sources include National Gene Bank of NBPGR, New Delhi; N. D. University of Agriculture and Technology, Faizabad; Central Rice Research Institute Cuttack, and farmers of Basti, Deoria, Gorakhpur, Sant Kabir Nagar, Siddharth Nagar, Kushinagar and Mahrajganj districts. Extensive testing of hundreds of collections of Kalanamak was done. It was not surprising to find out that some of the collections of Kalanamak were non-aromatic although the grain appearance was identical to Kalanamak. Some accessions had mixtures of scented and non-scented Kalanamak in various proportions. The pureline selection by following panicle-to-row method done 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 *et al.*, 2008).

Development and Release of Bauna Kalanamak 101

Bauna Kalanamak 101 was developed out of a cross Kalanamak KN 3 with Swarna Sub_1 and tested as UPCAR-KN-2-19-14-1-1. Regional Agricultural Technology Demonstration and Testing Station (RATDS) of Department of Agriculture conduct varietal trials annually on the new varieties to be considered for release. PRDF had proposed a number of semi-dwarf breeding lines of Kalanamak for testing.

These breeding lines were tested at RATDS during the years 2012 to 2015 in state trial called "Paddy Standard Varietal Trial: local aromatic, irrigated". The average yield superiority of UPCARKN-2-19-14 was 46.41 over its check Kalanamak KN3. It was released by the State Variety Release Sub-Committee in 2016. The Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops of Government of India 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 UPCARKN-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. Its plant height is around 95cm, lodging resistant and suitable for harvesting by combine harvester. Based on the overall test, the test entry UPCARKN-1-5-1 (Bauna Kalanamak 102) yielded 32.37 quintal / ha.

That way it out-yielded the check variety Kalanamak KN3 by 30.37%. Bauna Kalanamak 102 matures earlier than Kalanamak KN3 by 10 days. In all India trials (AICRIP) conducted by Indian Institute of Rice Research (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 Department of Agriculture, and notified by Government if India as "Bauna Kalanamak 102" and notified by Government of India.

Development and Release of Kalanamak Kiran

Selected out of cross of Kalanamak KN3 and Swarna Sub_1, 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 as equal to KN3. It is semi-dwarf (height around 95cm), lodging resistant and suitable for harvesting by combine harvester. Bauna Kalanamak 102 has the same level of Iron and Zinc as its original parent Kalanamak and thus worthy of inclusion in the NutriFarm schemes and any other biofortification schemes. It is under Notification by the Government of India during 2018.

Morpho-agronomic Characters

Kalanamak is strongly photoperiod sensitive variety with short basic vegetative phase and heads during mid October. Its morpho-agronomic characters are given in Table 2.

Table 2: Distinguishing morpho-agronomic characters of Kalanamak KN 3 and Bauna Kalanamak 101 and Bauna Kalanamak 102 rice varieties

Agronomic traits	Kalanamak KN 3	Bauna Kalanamak 101	Bauna Kalanamak 102	Kalanamak Kiran
Basal leaf sheath colour	Green	Green	Green	Green
Seedling vigour	Vigorous	Vigorous	Vigorous	V igorous
Seedling height (cm)	30.5 cm	25 cm	25 cm	25 cm
Days to 50% flowering	115 days (photosensitive)	110 days (photosensitive)	110 days (photosensitive)	110 days (photosensitive)
Tillering ability	Medium	Medium	Medium	Medium
Culm angle	Slightly Open (45^0)	Slightly Open	Slightly Open	Slightly Open
Leaf length	59 cm.	59 cm.	59 cm.	55 cm.
Leaf width	1.4 cm.	1.4 cm.	1.4 cm.	1.4 cm.
Culm length	111 cm. (stiff)	65 cm. (stiff)	65 cm. (stiff)	65 cm. (stiff)
Plant height	142 cm.	95 cm.	95 cm.	95 cm.
P anicle length	31 cm.	35 cm.	35 cm.	36 cm.
Maturity	145 days (Photosensitive)	135 days (Photosensitive)	135 days (Photosensitive)	135 days (Photosensitive)
Aroma (scent code)	Highly scented	Highly scented	Highly scented	Highly scented
Panicle type	Open	Open, large	Open , large	Open, large
Panicle exertion	Well exerted	Well exerted	Well exerted	Well exerted
Apiculus colour	Brown (tawny)	Brown (tawny)	Brown (tawny)	Brown (tawny)
Awning	Absent	Slight	Absent	Absent
Lemma, Palea colour	Purplish Black	Purplish Black Brown	Purplish Black Brown	Purplish Black
Stigma colour	Purplish Black	Purplish Black	Purplish Black	Purplish Black

Grain quality

Kalanamak is known for its excellent grain and eating quality (Table 3). Kalanamak should be cultivated only during Kharif season to maintain its grain quality. Kalanamak and the four varieties developed so far have short grain and classed as Medium Slender variety. These have very high (70%) head rice recovery. These cook soft and have excellent grain elongation (Table 3). In all India testing under AICRP, coordinated by Indian Institute of Rice Research, 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, it was the only variety from north India that was included in the NutriFarm Project of the Ministry of Agriculture, Government of India. Government of U.P. has included Kalanamak in the NutriFarm project also.

Table 3: Grain quality characters of Kalanamak KN 3 and Bauna Kalanamak 101 and Bauna Kalanamak 102 rice varieties (analysed at NRRI and NDUAT).

Traits	Description of the variety			
	Kalanamak KN3	Bauna Kalanamak 101	Bauna Kalanamak 102	Kalanamak Kiran
Kernel length	5.76 mm	5 .76 mm	5.76 mm	5.76 mm
Kernel width	2.18 mm	2.18 mm	2.18 mm	2.18 mm
L/B Ratio	2.64 mm	2.64 mm	2.64 mm	2.64 mm
Grain type	Medium slender	Medium slender	Medium slender	Medium slender
Kernel colour	White	White	White	White
1,000 grain weight	15 grams	15 grams	15 grams	15 grams
Hulling	80 %	80 %	80 %	80 %
Milling	75 %	75 %	75 %	75 %
Head rice	70 %	70 %	70 %	70 %
Alkali value	6 - 7	6 - 7	6 - 7	6 - 7
Volume Expansion Ratio	4.5	4.5	4.5	4.5
Gel consistency	80 mm	80 mm	80 mm	80 mm
Amylose content	21 %	22 %	22 %	21 %

Scientific cultivation practice of Kalanamak

Due to small grain size, lower 1,000-grain weight, 30 kg / ha, seed rate is recommended. Ideal time of its nursery sowing is last week of June to first week of July. Once the seedlings have attained the age of about 30 days, these are ready for transplanting. A temperature ranges of 25 to 30 degree Celsius is ideal for aroma retention in the grain. If the temperature is higher than 30 degrees Celsius, the leaves will synthesise the aroma but it will not accumulate in the grain. For raising nursery of Kalanamak, wet seedbed method of raising the nursery is recommended. In case green manuring is not possible 6 – 10 tonnes of FYM or compost should be applied before ploughing. It has also been found by experienced farmers that application of 2 quintals of Neem cake is useful not only to supply the Nitrogen but also to reduce the incidence of pests and diseases.

Fertilizer dose of 60: 30: 30 kg/ha for KN3 and 120:60:60 N: P: K kg/ ha for Bauna Kalanamak is needed. Transplanting is done using 20 cm X 15 cm spacing. Weed management are easier for Kalanamak due to its vigorous vegetative growth. Harvestings is done by the end of November. Sheath blight and grain sucking pests need to be controlled.

Protocol for Organic Production of Kalanamak

Protocol for producing organic Kalanamak rice was developed based on the multi-location and multi-year trial (Table 2). Based on the results a manual prepared for farmers (Chaudhary and Mishra, 2016) using *Trichoderma and Pseudomonas* in combination showed synergistic effect and increased the yield (Table 2). 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 district has been selected under *Paramaparagat Krishi Vikas Yojna* (PKVY) for organic farming. Organic production of Kalanamak rice is adding fuel to the fire of increasing the area under Kalanamak and tripling farmers' income on much larger scale.

Table 4: Yield of rice grain (q/ ha) in different treatments at various locations, Kharif 2012

Treatment	Gorakhpur	Mahrajganj	Sidharth Nagar
Control (No treatment)	2,133	2,292	3,147
Basal only	2,467	2,663	3,353
Basal + Pseudomonas	2,333	2,488	3,233
Basal + *Trichoderma*	2,417	2,917	3,200
Basal + *Trichoderma* + *Pseudomonas*	3,062*	3,597*	3,583*
LSD 0.005	206.00	197.24	115.13

* Highest yield and significantly higher than all other treatments.
**Basal at Gorakhpur was *Herbozyme* @ 40 kg/ ha, at Mahrajganj, FYM @ 10 tons/ ha, and at Siddharth Nagar, Bhumi Shakti @ of 1,750 kg / ha.

Economics of Kalanamak and Tripling Farmers' Income

Due to poor yield, poor quality and lesser income as compared to HYV rice, area under Kalanamak had declined. However, now with the availability of better quality variety Kalanamak KN3 and high yielding ones like Bauna Kalanamak 101 and Bauna Kalanamak 102 those negatives have been annulled. Government announces Minimum Support Price (MSP) for fine rice around Rs. 1650/ qtl. However, most farmers cannot get that rate due to various reasons and are compelled to sell their paddy around Rs. 1000 to Rs. 1300/- qtl. Compared to that, Kalanamak rice sells between Rs. 2,500 to Rs. 3500/- quintal. Thus, now Kalanamak farmers are receiving triple income. Another feather the project has added is production of Organic Kalanamak that fetches 20 percent higher price. Taking an average yield of common rice 40 qtl/ha can give a gross profit Rs. 52,000/-. After deducting the cost of cultivation of Rs. 34,500/-, the net profit would be Rs. 17,500. Kalanamak KN3 and Bauna Kalanamak can give an average yield 25 and 35 quintal per ha respectively. This amounts to a gross profit between Rs. 75,000/- and Rs. 1,05,000/- per ha respectively to the farmers. Deducting a production cost of Rs. 30,625/- and Rs. 33,750/- per ha respectively, the net profit would be Rs. 44,375/- and Rs. 71,250/- per ha. The net profit would be as high as double to triple of the current common rice (Table 5). This should bring prosperity to the farmers of eastern U. P. Incremental income from the will be Rs. 39,375/- and Rs. 53,750/- respectively for KN 3 and Bauna Kalanamak. Production of Organic Kalanamak further benefits organic farmers by as much as Rs. 75,000/- per ha, which amounts to tripling the income.

Table 5: Comparative profitability of Kalanamak KN3, Bauna Kalanamak and Common rice, (2017)

Item	Common rice (BPT -5204)	Kalanamak KN3	Bauna Kalanamak	Organic Kalanamak
Rice area (ha)	924976	5,000	25,000	100
Average Yield (qtl/ha)	40	25	35	35
Selling price of paddy (Rs./qtl)	1,300	3,000	3,000	3,500
Gross Profit	52,000	75,000	1,05,000	1,22,500
Cost of Cultivation (Rs./ha)	34,500	30,625	33,750	30,000
Net profit (Rs./ha)	17,500	44,375	71,250	92,500
Incremental income in (Rs/ha)	0	39,375	53,750	75,000

Marketing Linkage to Assure Income

In the past, marketing and consumption of Kalanamak has been limited to eastern part of UP. and by those who migrated to other parts of India from this region. Now consumers and marketers are looking for diversification of Basmati market and promote local specialty rice varieties. Common slogan that "Basmati for your eyes and Kalanamak for your palate" is popular. Under this changed thinking, processers, marketers and consumers are coming up from far-and-wide. PRDF is

facilitating this expansion by generating awareness through publicity and exhibitions. Growing interest of consumers in Organic Food is also creating market for Kalanamak (Chaudhary, 2002). Under PGS certification, PRDF is producing "PGS INDIA Organic" certified rice. Recent policy of U. P. State Government of "One District One Product" Kalanamak rice has been assigned to district Siddharth Nagar for marketing which helps to increase the income at triples rate. Kalanamak has also received Geographical Indication (GI) mark for 11 districts of U. P., which will benefit farmers further (Vandana *et al*., 2010 and Chaudhary *et al*., 2017).

CONCLUSION

Improved varieties of Kalanamak rice namely KN3, Bauna Kalanamak 101, Bauna Kalanamak 102 and Kalanamak Kiran have been developed. Package of practices to produce common and organic Kalanamak rice and its certification have been developed. Hundreds of farmers are linked with the local and export markets on attractive terms for sales on long-term basis. Summarily compared to Rs. 17,500 / ha net profit from common HYV rice, Kalanamak KN3 will give Rs. 44,375, Bauna Kalanamak Rs. 71,500 and Organic Bauna Kalanamak Rs. 92,500 net profit per hectare. With the PRDF arranged contract growing, by involving farmers and marketing companies from Kharif 2018 onwards, tripling the net profit of the farmers will get assured sustainably. Thus, the proverb "Paddy and Poverty go together" is a myth now.

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