

## Effect of Nutrient Management Practices on Growth Yield and Nutrient Uptake in Basmati Rice

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### ABSTRACT

*Basmati, pronounced is a variety of long, slender-grained aromatic rice which is traditionally grown in India, Pakistan, Bangladesh and Nepal. As of 2019, India accounted for 65% of the international trade in basmati rice, while Pakistan accounted for the remaining 35%. Many countries use domestically grown basmati rice crops; however, basmati is geographically exclusive to certain districts of India and Pakistan. According to the Indian Government agency APEDA, a rice variety is eligible to be called basmati if it has a minimum average precooked milled rice length of 6.61 mm (0.260 in) and average precooked milled rice breadth of up to 2 mm (0.079 in), among other parameters. The areas which have GI tag for basmati rice production in India are in the states of Punjab, Haryana, Himachal Pradesh, Delhi, Uttarakhand, Western Uttar Pradesh and Jammu and Kashmir. India's total basmati production for the July 2011–June 2012 crop year was five million tonnes. From April 2018 to March 2019, India exported 4.4 million metric tons of basmati rice. In 2015–16, Saudi Arabia, Iran and UAE were the three biggest destinations for India's basmati rice exports and exports to these three countries accounted for more than half of India's total basmati exports. In 2015–16, basmati rice worth US\$3.4 billion was exported from India.*

*There are several varieties of basmati rice. Traditional Indian types include basmati 370, basmati 385, and basmati Ranbirsinghpura (R.S.Pura) and Gujjar Chack area in Jammu province situated at the India-Pakistani border in Jammu and Kashmir state of India. 1121 and Muradabadi 6465 Extra Long Grain Rice. Pakistani varieties of basmati rice are PK 385, Super Kernel Basmati Rice and D-98. Scientists at Indian Agricultural Research Institute, Delhi, used conventional plant breeding to produce a hybrid semi-dwarf plant which had most of the good features of traditional basmati (grain elongation, fragrance, alkali content). This hybrid was called Pusa Basmati-1 (PB1; also called "Todal", because the flower has awns); crop yield is up to twice as high as traditional varieties. Fragrant rices that are derived from basmati stock but are not true basmati varieties include PB2 (also called sugandh-2), PB3, and RS-10.*

**KEYWORDS:** *basmati rice, growth, yield, nutrient uptake, aromatic, varieties, fragrant, hybrid.*

## INTRODUCTION

- Selection of Land/Farm: Smooth lands with good water retention capacity and 6.5 to 8.0 pH suitable for paddy cultivation. Paddy cultivation can also be successfully done on a light loam land with adequate irrigation.[1,2]
- Selection of land for Nursery: – To prepare the nursery, the empty field after harvest of sugarcane or berseem will be an ideal choice. The land should be selected with suitable means of drainage, away from shade and adequate arrangement of irrigation. Weeds should be destroyed completely by running harrows and cultivator.
- Area and nutrients for the nursery: – For 1000 square meters, use 1000 kg of compost with 0.5 kg *Trichoderma viride* and 0.5 kg *Pseudomonas fluorescens*; or use 2-3 kg Zinc Sulphate for 1000 square meters. Apply 5 kg urea on the 10th day of the sowing.
- Farm preparation: – Prepare the farm by ploughing twice or thrice after the summer ploughing. The surface of the farm should be equal. Besides, the farm must bunds also be made strong in order to accumulate more rainwater. The land must be irrigated a week before planting paddy. During irrigation, spread 2 kg of Crop Tiger per acre in the field equally. Before transplanting, ploughing should be done with harrow twice or thrice and later, the land must be harvested and ploughed with tiller or paddler so that it becomes equal.
- Farm soil treatment: – Mix 150-200 kg cow dung manure / FYM / compost of leaves mixed with 2.0 kg *Trichoderma viride* and 2.0 kg of *Pseudomonas fluorescens*. Spray water for moisture and covered with a wet gunny bag/ polythene sheet. Remix the heap after 4 days and again cover the heap. After 7 or more days this mixture will be use for soil treatment and is sufficient for 1 acre.
- Selection of variety: – The selection of variety is very important to achieve good yield with the best quality. Select the suitable variety on basis of area, crop duration, yield, low or high water requiring and demand in market.
- Selection of healthy seeds: – Take a tub with half filled water and pour the whole seeds which is to be sown in nursery. Discard the floating seeds with the help of seive. Throw. The seeds settled at the bottom should be use for nursery sowing.
- Treatment of seeds: – Seed treatment is essential for the prevention of seed and soil borne diseases. Make a solution of Carbandiazem or Thiram @ 2g/kg seed and Pep-Rice primer (@10 ml per kg seed) in 40 liters of water. Soak 20-25 kg seeds in this solution for 24 hours. Take out these seeds from the solution and put them under a shade for sprouting. The seeds must be layered in 4-5 inches thick. Cover well with a wet sack. Keep spraying little water on the sack until the seeds are germinated. [3,4]Approximately after 36-48 hours the seeds must be completely germinated.



## BASMATI RICE

### For Organic Treatment

An organic treatment will be ideal for ultimate organic rice production. Make a solution Pep-Rice Primer (@10 ml/kg of seeds) and 250 gm *Trichoderma viride* and 250 gm *Pseudomonas fluorescens* in 50 liters of water. Soak 20-25 kg of seeds for 24 hours and follow the same procedure as mentioned above for sprouting.

- Selection of Fertilizer: – Fertilizer should be chosen after testing the soil. It is recommended not to use DAP or Single Super Phosphate with Zinc Sulphate. Use only the right amount of fertilizer; and After 30-35 days of transplantation, spray Zinc Pep 7000 of @ 1.0 -1.5 ml /liter of water. A total of 200 liters of this solution must be sprayed on 1 acre of land.

After 50-55 days of transplantation, spray Nano Aminofert Gold liquid @ 1.0 -1.5 ml /liter of water. A total of 200 liters of this solution must be sprayed on 1 acre of land.

- Process of Transplantation: – The field must be filled with water and ploughed twice or thrice. The seedlings of 20-25 days is best suited for transplanting. The distance between plant to plant and line to the line should be 15 to 20 cm. Always plant 2-3 plants at one place. Transplant the seedlings 1.0-1.5 inches deep. The field should have 2-3 inches of water at the time of transplanting. There should be 30-35 plants approximate minimum in one square meter.[5,6]

Before transplanting, mix 250 gms of *Pseudomonas fluorescens* powder in a solution of 20 liters of water and immerse the root of plants for 30-35 minutes, then plant it. This treatment is very useful for the prevention of Bakane disease, sheath blight, and other soil-borne diseases.

- Irrigation management: – The water must be maintained in field (2-3 inches) for 45 days after transplantation. The fields should have enough water at the time of bursting of blossoms, flowering, and grain formation. This makes phosphorus, iron and manganese elements easily available and also reduces weeds.
- Drain and weed control: – Use the khurpi or paddy weeder to destroy weeds in field or any weedicides / herbicide available in the market. But keep in mind that such chemicals must be use after 6-7 days from the treatment of *Trichoderma viride* and *Pseudomonas fluorescens*.[7,8]
- Harvesting and Storage:

Harvesting should be done when the crop is almost 90% mature. Store the grains after gradually drying. The good quality of the yield gets the right market value. For long-term storage, the farmer should dry the paddy well before storage.

#### **Useful information:-**

1. Level the farm with Laser Land leveler.
2. Must use FYM, compost or green manure in the field.
3. Must remove weeds from the main crop early before flowering.
4. Use a balanced fertilizer at the right time. Potassium, Zinc, and Ferrous must be provided to crop.
5. Seedlings must be planted straight and not diagonally. Depth may not exceed 1 – 1.5 inches.[9,10]
6. Soak the roots of plants in the solution of *Trichoderma viride* and treat the soil with *Trichoderma viride* & *Pseudomonas fluorescens* to prevent blast blight and Bakane disease.
7. Keeping the water level of 3-5 centimeters of planting for 45 days after transplantation.
8. Keep track of disease and insects by frequent observation of field and manage at the early stage.

#### **DISCUSSION**

Scented (Basmati) rice, a unique product of the Indo-Gangetic Plain, is known for its aromatic quality and high economic value. It generates about three times higher prices than coarse rice. Approximately 20% of the land used to cultivate rice grows scented rice in India, and northwest states account for more than 90% of its total production. India contributes around 65% of the total global supply of scented rice. The sustainability of the Basmati rice production in India has become a significant concern due to alarming water table depletion, growing food demand, stagnating, or declining productivity growth, and diminishing economic returns.

Traditionally, rice is a water-intensive crop and requires water for three primary purposes – preparing land (puddling), continual seepage, percolation, and growing the produce. The farmer growing Basmati rice has to keep the area spread continually flooded, which results in substantial unproductive water

losses (up to 80%) for reasons other than rice cultivation. The crop demands high water investments, labor, pre-crop preparation, and fertilizers. Despite these investments, farmers don't get the expected returns because water inefficiency resulting lower crop yield, and reduced crop quality affects their profits. [11,12]

Globally, India is one of the top basmati and non-basmati rice exporters. According to the statistics, in 2020-21, India's rice exports (Basmati and Non-Basmati) rose by a massive 87 percent to 17.72 million Tonne (MT) from 9.49 MT achieved in 2019-20. In terms of value realization, India's rice exports rose by 38 percent to USD 8815 million in 2020-21 from USD 6397 million reported in 2019-20. In terms of volume of Basmati rice exports in 2020-21, the top ten countries – Saudi Arabia, Iran, Iraq, Yemen, United Arab Emirates, United States of America, Kuwait, United Kingdom, Qatar, and Oman have a share of close to 80 percent in total shipments.

To achieve sustained growth in farmers' income and continue dominating the global export market for scented rice, ensuring scientific and egalitarian water application in agriculture and minimizing wastage of water is paramount. The Indo-Gangetic plain (IGP) is an environmentally susceptible, communally momentous, and economically tactical sphere of India where landscape, groundwater, and soil fertility are threatened by climate change. The expensive land preparation, wastage of water through flooding, and the inefficiency of conventional techniques add to rice growers' hurdles. Under these emerging scenarios, the farmers must focus on efficient alternative approaches for water use and start implementing drip irrigation for rice cultivation. Currently, the total area of rice under drip irrigation is around 500 Ha in India. Undoubtedly, it becomes imperative to introspect and overhaul agriculture practices in rice cultivation while acknowledging the efficiency that these upgrades would bring into the system.

Drip irrigation reduces water use through a precise water supply to the crop. So, for the one kilo of rice that the farmers used to grow in 5000 liters of water conventionally, they now need only 1500-1600 liters. They achieve a higher crop yield on a large scale in lesser water. Drip irrigation allows farmers to choose any desired close spacing crop after rice in crop rotation. They can also shift from low-income crops to high-income ones after cultivating rice. In paddy farming, rice roots remain submerged. They consume heavy metals and increase the arsenic in the harvest, thereby reducing the crop's market value. However, drip irrigation helps reduce the arsenic uptake by around 90% and further results in a high-quality and marketable crop growth. [13]

The farmer community could reduce labor costs with drip irrigation, achieve water efficiency, increase crop yield, and improve crop quality. All of these factors reduce investments and increase profits. Additionally, Paddy cultivation produces around 10% of methane gas emissions globally. But, even if only 10% of paddy rice cultivators upgrade to drip irrigation, the world will be able to reduce methane emissions equivalent to those of a staggering 40 million cars. Controlled application of water and fertilizer has increased the productivity of the crops by 50%. All these boost farmer income levels by more than 40%.

The backbone of the success of drip irrigation in rice cultivation is awareness generation and practical training amongst small and marginal farmers in potential states. Studying the current drip-irrigation programs, Indian rice growers must adopt the technology at full scale with proper and accelerated execution. Continuing to tread the path of adopting suitable technology will make doubling farmers' income an achievable goal.

Basmati Rice means the rice varieties possessing aroma and gives pleasant flavour after cooking. In India Basmati rice is characterized by extra long, superfine slender grains having a length to breadth ratio of more than 3.5, sweet taste, soft texture, delicate curvature and an extra elongation with least breadth-wise swelling on cooking. The Basmati rice is also stated to be the Pearl of Rice.

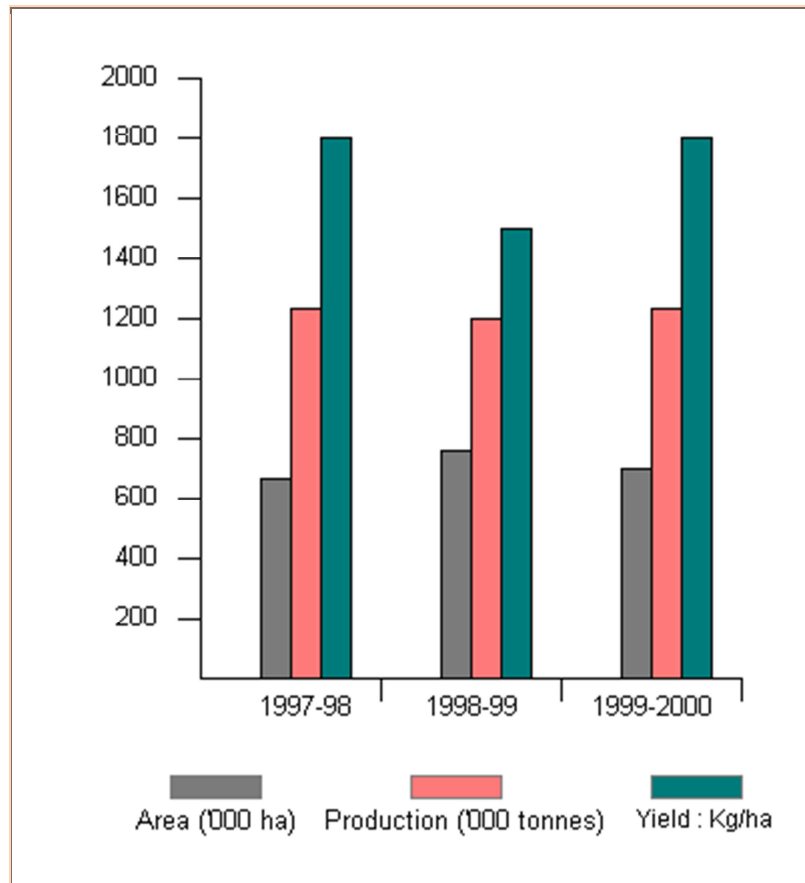


These superfine best quality of Basmati rice are most preferred specially for Biryani and Pulao preparation on special occasion and also meant for high premium value in the national and international market.

### TRADITIONAL AREA

Basmati rice is mostly grown in the traditional areas of north and north western part of Indian sub-continent for many centuries. The super-fine best quality of Basmati rice is produced on either side of Indus valley in India. Its different varieties are mostly cultivated in the districts of Karnal, Panipat, Kurukshetra, Kaithal, Amritsar, Fatehgarh, Gurudaspur, Hoshiarpur, Jalandhar, Patiala, Ropar and Sangrur in Punjab; Kangra, Solan, Una, Mandi and Sirmour in Himachal Pradesh; Bundi in Rajasthan and in several districts of Uttar Pradesh. Some important districts of Uttar Pradesh are Saharanpur, Muzaffar Nagar, Pilibhit, Bareilly, Bijnour, Moradabad, Jyotibaphule Nagar, Rampur, Raibareilly, Sitapur and Udham Singh Nagar; Haridwar and Dehradun in Uttaranchal. Also, Basmati rice is grown to limited extent in Jammu and Kashmir. Various aromatic varieties of Basmati rice grown in India is given in Table-1.

**Area, Production and Yield of Basmati Rice**



The total area presently under cultivation of Basmati rice is about 7,76,000 hectares in India and its production estimated at about 11,96,000 tonnes during 1998-99. There is a substantial increase of Basmati in traditional Basmati growing areas. The largest area under Basmati rice is in the State of Haryana (60%) followed by Uttar Pradesh (17.1%) and Punjab (16.1%). During 1998-99, the State of Haryana contributed nearly 55% of the total Basmati rice production in the country followed by Uttar Pradesh at 23.5% and Punjab at 12.4%. The productivity of Basmati rice ranges from 15 to 18 Quintals/Hectare. The lower yield of Basmati rice is known for its tall and weak stature of the plant

causing lodging. Besides, poor response of the fertilizers, susceptibility to pests and diseases and less number of spike lets per panicle. State-wise area, production and yield of Basmati rice during 1997-98 to 1999-2000 are given in Table-2.

**Table-1: Varieties of Basmati/Aromatic Rice in India**

Sl	State	Small Grain
1.	Uttar Pradesh	Adamchini, Badshah Pasand, Bindli, Bhartaphool, Dhania, Chhoti Chinnawar, Laungchoor, Jeerabattis, Kanak Jeeri, Yuvraj, Moongpholi, Rambhog, Ramjawain, Sakkarchini, Tinsukhia, Bengal Juhi, Thakur Bhog
2.	Haryana	-
3.	Punjab	-
4.	Himachal Pradesh	-
5.	Rajasthan	-
6.	Jammu & Kashmir	-
7.	Mizoram	-
8.	Madhya Pradesh	Chinore, Dubrej, Kalimooch, Bishnubhog, Badshah Bhog, Tulsi-Manjari
9.	Bihar	Badshah Bhog, Deobhog, Karia Kamod, Katarni, Tulsi-Manjari, Shyam, Jeevan, Kanak Jeera, Kanak Jeeri, Badshah Pasand, Mircha, Bramobhusi, Ranjawain, Karina, Tulsi Pasand, Dewatabhog, Chenaur, Sonalari, Sataria,
Sl	State	Medium Grain
1.	Uttar Pradesh	Karmuhi, Kesar, Kesarparsom, Sonachur, Tilakchandani, Kalanamak, Vishnu Bhog
2.	Haryana	-
3.	Punjab	-
4.	Himachal Pradesh	Achhu, Begru, Panarsa (local)
5.	Rajasthan	-
6.	Jammu & Kashmir	-
7.	Mizoram	-
8.	Madhya Pradesh	Chatri, Modhuri, Vishnu Parag
9.	Bihar	Gopal Bhog, Champaran Basmati (Lal), Champaran Basmati (Kali), Champaran Basmati (Bhini), Bhilahi Basmati, Amod, Abdul, Baharni, Kalanamak, Kesar, Sonachur
Sl	State	Long Grain
1.	Uttar Pradesh	Basmati-370, Dehradun Basmati, Lalmati, Type-3, Hansraj, Nagina-12, Safeda, Kalasukhdas, Tapovan Basmati, Type-9, Duniapat Dabraj, Ranjavain (T-1) Kasturi, Pusa Basmati-1, Taraori Basmati.
2.	Haryana	Haryana Basmati-1, Taraori Basmati, Basmati-370, Khalsa-7, Karnal Local, Pakistani Basmati.
3.	Punjab	Basmati-370, Pusa Basmati-1, Pakistani Basmati, Basmati-385.
4.	Himachal Pradesh	Baldhar Basmati, Madhumati, Mushkan, Seond Basmati.
5.	Rajasthan	Kasturi, Pusa Basmati-1, Basmati-370, Basmati (local).
6.	Jammu & Kashmir	Basmati-370, Ranvir Basmati.
7.	Mizoram	Pusa Basmati-1
8.	Madhya Pradesh	Laloo.
9.	Bihar	Baikani

Table-2: State-wise Area, Production &amp; Yield of Basmati Rice

Year : 1997-1998				
Sl	State	Area ('000 ha)	Production ('000 Tonnes)	Yield (Kg/Hectare)
1.	Haryana	346.00	632.00	1,827
2.	Himachal Pradesh	1.00	2.10	2,100
3.	Jammu & Kashmir	18.50	37.25	2,014
4.	Punjab	121.00	164.00	1,355
5.	Rajasthan	24.78	61.96	2,500
6.	Uttar Pradesh	171.86	354.27	2,061
•	Total	683.14	1,251.58	1,832

Year : 1998-1999				
Sl	State	Area ('000 ha)	Production ('000 Tonnes)	Yield (Kg/Hectare)
1.	Haryana	466.00	663.00	1,423
2.	Himachal Pradesh	-	-	-
3.	Jammu & Kashmir	24.07	46.84	1,946
4.	Punjab	125.00	148.00	1,184
5.	Rajasthan	28.74	57.47	2,000
6.	Uttar Pradesh	132.82	281.15	2,117
•	Total	776.63	1,196.46	1,541

Year : 1999-2000				
Sl	State	Area ('000 ha)	Production ('000 Tonnes)	Yield (Kg/Hectare)
1.	Haryana	467.00	789.00	1,690
2.	Himachal Pradesh	-	-	-
3.	Jammu & Kashmir	24.07	46.84	1,946
4.	Punjab	-	-	-
5.	Rajasthan	46.29	88.48	1,911
6.	Uttar Pradesh	148.19	311.96	2,105
•	Total	685.55	1,236.28	1,803

## RESULTS

The government has been persuading farmers in far western Nepal to grow Hansaraj basmati rice commercially because of its export potential. The indigenous aromatic rice is not grown on a large scale despite swelling demand, and Nepal has been importing it from India to satisfy the palates of urban consumers with growing incomes. The Agriculture Knowledge Centre, formerly known as the District Agriculture Office, has launched a special project to encourage paddy farmers to grow the fragrant grain commercially from this fiscal year which began mid-July.

Demand for aromatic rice has jumped manifold among Nepalis who have become more discerning along with higher earnings, particularly in large cities like Kathmandu and Pokhara.



Long grain basmati rice holds a unique charm in global markets including Nepal, and this has resulted in a growth in rice imports although the country produces surplus grain which is of improved variety, agro experts said.[

According to Nepal Rastra Bank, the country imported rice worth Rs50.48 billion in the last fiscal year, up a whopping 51.4 percent year on year. Basmati rice accounted for most of the shipments, insiders said.

“As per the project, the Agriculture Knowledge Centre will help farmers in packaging, bagging, labelling and marketing the rice,” said Tek Bahadur Bista, chief of the centre. “It is unfortunate that Nepal has for a long time failed to market such rich rice.”

He added that achieving success in marketing the rice variety would consequentially lead to huge demand. “In the first year, the Agriculture Knowledge Centre will support farmers to market their products by launching various schemes,” said Bista.

The centre plans to package the rice harvested in November and sell it in urban areas like Mahendranagar, Dhangadhi and Kathmandu in the first phase.[14,15]

The government has started to realise the potential of indigenous and exportable rice after India applied for a geographical indication (GI) tag to basmati rice in the European Union (EU) in July 2018. Nepal submitted an opposition letter along with proof of origin, diversity, cultivation and use values of basmati rice on December 9, 2020.

GI is intellectual property rights that have a specific geographical origin and possess qualities or a reputation that are due to that origin.

Basmati is long grain aromatic rice grown for many centuries in a specific geographical area, mostly in the Himalayan foothills of the Indian subcontinent.

This rice has extra-long slender grains with a soft and fluffy texture upon cooking, delicious taste, superior aroma and distinct flavour.

According to a journal entitled Intellectual Property Right on Basmati Rice: Current Scenario and Evidence of Origin, Diversity, Cultivation and Use Values of Basmati Rice in Nepal, authored by nine researchers and published in July, many countries have been attempting to get intellectual property rights, mainly geographical indication tag, on basmati rice because of its high market value at the global level.

The journal said that a total of 133 basmati type rice landraces are grown in 60 districts of Nepal. Basmati rice has been traditionally grown and sold and consumed in geographically localised areas of Nepal since ancient times.

International and national scientists have defined the lower altitudes of Nepal as one of the centres of origin of basmati rice.

Many Nepali basmati rice landraces have been characterised and evaluated using morphological traits, isozymes and DNA markers. Four basmati types of rice landraces have been registered at the National Seed Board. They are Pokhrela Jetho Budho rice registered in 2006, Lalka basmati registered in 2010, and Suddhodhan Kalanamak and Kalonuniya, both registered in 2020.[16,17]

## CONCLUSIONS

The National Agriculture Genetic Resources Centre and international genebanks have collected more than 80 basmati landraces and conserved 68. Basmati rice landraces have geo-linked traits.

The historical culture of production, consumption and marketing of native basmati rice in Nepal

should always be favoured by both national and international rules and regulations, according to the journal.

Nepal has ample and valid evidence to get geographical indication right on basmati rice, the journal said.

As a pilot project, the government has started to grow the rice commercially to stem imports and reduce the trade deficit, according to experts.[18]

Hansaraj is grown in Bajhang, Baitadi, Darchula, Dadeldhura, Jhapa, Kanchanpur, Morang, Palpa, Pyuthan, Salyan, Sunsari, Surkhet and Syangja. The aromatic rice is grown at altitudes ranging from 60 to 1,100 metres.

Farmers in Bajhang have expanded their paddy acreage this year after receiving assurances from the centre. They have transplanted Hansaraj basmati on 2,000 hectares out of the 7,500 hectares under paddy cultivation this year.

“Following the centre's assurance, farmers who had almost abandoned cultivating Hansaraj basmati have transplanted this variety,” said Paru Rokaya, a farmer in Thalara, Pkhet. Thalara is the key Hansaraj basmati producing area in the district.[19]

“If we get markets and good prices this year, we have decided to transplant this variety on all the available land next year,” she said. The district produces 22,000 tonnes of paddy annually.

“Most indigenous paddy varieties like Hansaraj basmati are heading towards extinction as farmers have been using improved varieties of seeds to get higher productivity,” said Ram Prasad Joshi, president of the Federation of District Farmers Group. “Due to high pest infection and low productivity, farmers give indigenous varieties the lowest priority.”[20]

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