

REVITALIZING NATIVE AROMATIC RICE VARIETIES: A NEW HOPE FOR THE RURAL BIOTECHNOLOGY SECTOR IN INDIA

Abstract

Rice is integral part of Indian tradition and it is considered "Holy Grain" in country. India is centre of origin of rice thus it has great level of diversity. Jharkhand state alone is native place for more than one thousand rice varieties, of which few are having scented characteristics with distinct pleasant aroma and flavour. These scented rice varieties are mostly short grained type and some are having medium grained character. Aroma of these scented rice varieties are very much location specific. Separate indigenous aromatic rice varieties are grown for all type of land topography viz. upland, mid-land and low land, under rainfed conditions in the state. Changing climatic conditions, introduction of high yielding/ hybrid varieties, lack of scientific interventions and unorganised market had forced farmers to confined indigenous scented rice varieties cultivation for own consumption only. An attempt was made for promotion of indigenous rice varieties of Jharkhand state by with ten most popular scented varieties. These varieties were grown to obtain pure seeds by removing off type mixture. A multi-location trial was conducted at five different locations of Ranchi district on farmer's field to assess most promising variety with market preference following standard improved growing practices through organic inputs. Biological methods for disease and pest control were followed. Two varieties namely Bhutaku and Tulasi Mukul were selected for commercialization based on farmer's response and market needs. Seed

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production programme for large scale area expansion was carried out on participatory mode at farmer's field for these two varieties. Promotion programme were organised to aware consumers and generate demand. Farmers were provided marketing linkages which has insured the boost up of B: C ratio of rice growers from 1.33 to 2.56. With the better return, increasing market demand and climate resilient cultivation techniques area as well as production of these two heirloom varieties has turn up many folds.

Keywords: aroma; food security; native varieties; rainfed condition; rural biotechnology; scented rice

I. INTRODUCTION

Biodiversity especially in crop plants is very essential to ensure food security for present and future world. It provides raw material needed for ensuring continuing food supplies for tomorrow. Crop diversity enables farmers and plant breeders to develop high yielding varieties with desired quality characteristics like taste, nutrition, flavour, aroma etc. [1]. Crop diversity also known as plant genetic resources, is a key component of crop improvement programs in which breeders can produce varieties having tolerance to biotic and abiotic stresses which give sustainable production in extreme climatic conditions[2]. These resources are not only essential to reduce hunger but also to strengthen global food security in the medium and long term by contributing in crop improvement programmes. Bio diversity in agriculture is foundation of our sustainable production system due to its importance in socio-cultural, economic and environmental elements[3].

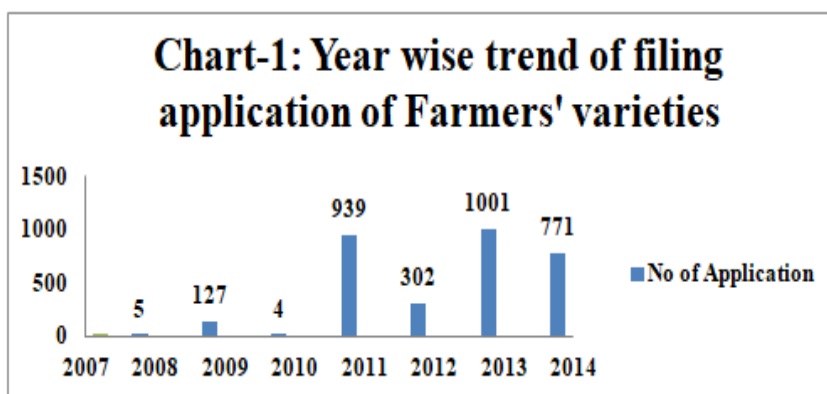
Agro biodiversity is defined as the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties & breeds) and species used for food, fodder, fibre, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators) and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest and aquatic) as well as the diversity of the agro-ecosystems(Source: FAO, 1999a). In the present scenario biodiversity is of prime importance to cope emerging challenges like climate change, increasing diseases and pests, pressure to feed growing human population and water scarcity etc.[4]. There is increasing evidence that agricultural biodiversity needs to be a central element of sustainable agricultural development.

Jharkhand is a part of Chhotanagpur plateau of Eastern India. Being the oldest landmass of the earth, the plateau is geo-historically considered as unique region. The plateau is one among the 22 Agro biodiversity hot spot in India, as it is very rich in floristic diversity and endemism of species. It has immense diversity of rice (*Oryza sativa*), maize (*Zea mays*), kodo (*Paspalum scrobiculatum*), gundli (*Panicum antidotale*), sorghum (*Sorghum bicolor*), barley (*Hordeum vulgare*), pigeon pea (*Cajanus cajan*), horse gram (*Macrotyloma uniflorum*), black gram (*Vigna mungo*), nizer (*Guizotia abyssinica*), sunhemp (*Crotalaria juncea*), rice bean (*Vigna umbellata*), moth bean (*Vigna aconitifolia*), Brassica Species (*Brassica oleracea* var. *botrytis*, *B. oleracea* var. *gemnifera*, *B. oleracea* var. *capitata*), brinjal (*Solanum melongena*), cucumber (*Cucumis sativus*), ivy gourd (*Coccinia indica*), taro (*Colocasia esculanta*), yam (*Dioscorea esculanta*), ginger (*Zingiber officinalis*), turmeric (*Curcuma longa*) and wild relatives like *Cajanus scarabaeoides*, *C. cajanifolia*, *Curcuma aromatic*, *Dioscorea belophylla*, *D. kalkapershadii*, *D. wightii*, *Momordica balsamina*, *Musa sapientum*, *Oryza nivara*, *O. rufipogon*, *Rhynchosia bracteata*, *R. minima*, *R. rufescens*, *Vigna hainiana*, *V. trilobata*[5].

II. ROLE OF KVK IN CONSERVATION OF AGRO BIODIVERSITY IN COLLABORATION WITH PPVAND FRA

India is among the first few countries in the world to have passed a legislation granting farmers right in the form of the protection of plant varieties and farmers rights act, 2001 (PPV&FR Act). India's law is unique in that, as it simultaneously aims to protect both plant

breeders and farmers. It attempts to establish rights for farmers to register their innovations and protect extant varieties and is also negotiating internationally to ensure protection of farmers' right. To implement the provisions of the act the Department of agriculture and cooperation, Ministry of Agriculture, New Delhi has established the Protection of Plant Varieties and Farmers' Rights Authority in November 2005. During the initial implementation phase of plant variety protection law, the response for filing of applications was slow and inconsistent which led the authority to plan detailed awareness and capacity building programmes involving all stakeholders who in turn trained the scientists & farmers regarding the provisions in act as well as their need and benefits.



In India, Krishi Vigyan Kendras (KVKs) also known as Farm Science Centres are integral part of National Agricultural Research System (NARS) aims at assessment of location specific technology modules in agriculture and allied sector through technology assessment, refinement and demonstrations. KVKs are having grass root level co-ordination with the extension system and farmers for frontline technology transfer in country. At present 721 KVKs are working in the country under the coordination and monitoring of 11 different Agricultural Technology application Research Institutes at zone level. During 2013-14 Indian Council of Agricultural Research (ICAR) and Protection of Plant Varieties and Farmers Right Authority jointly assigned responsibility to the 161 KVKs, which were situated in biodiversity rich regions, to organize awareness programmes in their respective districts [6].



Awareness Program in Khunti District, Jharkhand



Tribal Farmer's Participation in Awareness Program

Twenty four selected KVKs of then Zone-II (Bihar, Jharkhand and West Bengal) had conducted awareness programme on PPV & FRA in the year 2013-14. As a result, a record number of applications (1001) of farmers' varieties of 35 crops were filed for Intellectual Property Rights protection (Shown in Chart-1). Out of 1001 farmer's varieties applications form received by authority, 931 applications were only from Zone II. Among these 931 applications almost half (439) were for registration of paddy varieties only which clearly show rich diversity of this crop in the region.

Krishi Vigyan Kendra, Ranchi, Jharkhand (which was in zone II then and presently under Zone IV) has taken up awareness programme for PPV & FR from the 2013 with financial support of PPV & FR Authority, New Delhi which were concluded during the year 2018. Every year 2 to 3 awareness programme were conducted by the KVK in remote tribal areas of the district and adjacent district Khunti to create awareness among the farmers. These programmes were very effective in accelerating registration process of farmers' varieties. Year wise details of awareness programme organised by KVK Ranchi have been given in table 1. In the very first year *i.e.* 2013-14 with the participation of 125 farmers, 148 applications were filed for registration as farmer's variety under 18 different crops. Out of 148 farmer's application, 96 were for paddy varieties, as it is a traditional crop of Jharkhand with huge diversity in state. By the year 2019, about 5000 varieties were registered through the Krishi Vigyan Kendras of the country (Source: ICAR-Agricultural Technology Application Research Institute, Kolkata).

Table1: Year Wise Details of Awareness Programme Conducted by KVK, Ranchi

Year	No. of Awareness Programme organized	No of total participants	No. of Applications filled by Farmers	No of crops
2013-14	1	125	155	18
2014-15	2	300	127	18
2015-16	4	515	130	14
2016-17	2	218	24	11
2017-18	1	210	30	12
Total	10	1368	466	

Altogether 450 applications of farmer's varieties were submitted to PPV& FR Authority for registration through KVK, Ranchi between the year 2013 to 2018 (Table 2) as a result of its awareness activities. Among these 276 applications were filed in the category of cereal crops like paddy, wheat, maize, finger millet, pearl millet, barley, sorghum, 57 applications were filed for pulses varieties like pigeon pea, field pea, black gram, lentil, chick pea, green gram, 25 applications were for oilseed crops like mustard, sunflower, sesame, safflower, castor, linseed and groundnut, 46 applications for vegetable crops like potato, brinjal, dolichosbean, pumpkin, cucumber, ridge gourd, cow pea, chilli, tomato and bitter gourd, 26 for spices like turmeric and ginger, 17 applications were related to fruit plants like mango, ber, papaya, banana, guava, acid lime, and 3 applications for fibre crop jute. Highest number of applications is received in Rice (213) followed by finger millet (23), black gram (19), turmeric (14) etc.



Application Filing and Sample Collection under PPV & FRA

Table 2: Crop Group Wise Application Send to PPV and FRA for IPR

Category	2013-14	2014-15	2015-16	2016-17	2017-18	Total
Cereals	108	72	71	11	14	276
Pulses	17	13	19	4	4	57
Oilseed	12	5	6	1	1	25
Vegetables	3	22	8	6	7	46
Spices	8	14	-	1	3	26
Fruit Plants	-	12	5	-	-	17
Others (Jute)	-	1	-	1	1	3
Total	148	139	109	24	30	450

Against these applications, 42 claims were accepted and certificates of registration were issued to them till December 2020 by PPV&FR Authority, New Delhi. Highest numbers of certificates of registration for farmer's varieties were issued for paddy (39), whereas 2 certificates in pigeon pea and 1 in mustard were issued. The certificate of registration issued will be valid for nine years in case of trees and vines and six years in case of other crops, which may be further reviewed and renewed for another nine years in both cases.

Table 3: Registered Farmers' Varieties of Jharkhand under Ppv and Fra Through Kvk Ranchi

Sl. No.	Name of Farmers' Variety (Denomination)	Crop	Registration Number
1.	HarikhuntaDhan	Paddy	307 of 2016
2.	Netakalani	Paddy	199 of 2016
3.	Barabali	Paddy	198 of 2016
4.	TewanDhan	Paddy	197 of 2016
5.	Sindoor Sal	Paddy	203 of 2016
6.	ChhotaDahiya	Paddy	206 of 2016
7.	Rajnigandha	Paddy	302 of 2016
8.	DhadhmainiDhan	Paddy	311 of 2016
9.	BageriSona	Paddy	200 of 2016
10.	Barhabali	Paddy	211 of 2016
11.	NagrabaliDhan	Paddy	381 of 2018
12.	RamdiArhar	Pigeon Pea	383 of 2018
13.	MayinSarson	Mustard	155 of 2016
14.	Meghjawain	Paddy	56 of 2020
15.	Safed Lalak	Paddy	201of 2016
16.	Lal Sita Sal	Paddy	310 of 2016
17.	DigambarDhan 1	Paddy	204 of 2016
18.	Bachakolma	Paddy	215 of 2016
19.	HajrakhuntaDhan	Paddy	308 of 2016
20.	JeeraBhog	Paddy	317 of 2016
21.	TulsiManjar	Paddy	205 of 2016
22.	Hadrasal	Paddy	212 of 2016
23.	Lauhonchi	Paddy	202 of 2016
24.	KolhinKhosa	Paddy	303 of 2016
25.	TulsiMukul	Paddy	312 of 2016
26.	Sursuriya	Paddy	232 of 2019
27.	Sita Sal Dhan	Paddy	315 of 2016
28.	Balamsar	Paddy	223 of 2016
29.	BaraunGodaDhan	Paddy	316 of 2016
30.	ArakhutaDhan	Paddy	1 of 2017
31.	BadkaDhan	Paddy	2 of 2017
32.	SarnaArhar	Pigeon Pea	382 of 2018
33.	DahniGodaDhan	Paddy	233 of 2019
34.	Safed Hambala	Paddy	234 of 2019
35.	SonagutiDhan	Paddy	237 of 2019
36.	Sufal Dhan-1	Paddy	239 of 2019
37.	JerengDhan	Paddy	240 of 2019
38.	LalMotaDhan	Paddy	241 of 2019
39.	GodaKanau	Paddy	Reg/2014/2265
40.	Bacha Kolma	Paddy	215 of 2016
41.	Dev Dhan	Paddy	314 of 2016
42.	KodhaPhool	Paddy	217 of 2016

III. TRADITIONAL RICE VARIETIES OF JHARKHAND

Paddy is the major staple food in Jharkhand and it is farmer's choice crop in the state. Existences of large number of indigenous varieties having good traits are helpful in development of new varieties for further agricultural development. Expansion of area under HYVs/ hybrids for enhanced production and productivity is leading to drastic reduction in area under indigenous varieties which is a major cause of genetic erosion. Use of fewer HYVs over large areas for increasing yield has reduced the crop resistance to a lower level thereby more chemical application as nutrient supplement and pesticides are required. Local indigenous varieties have adjusted over long periods to the ecosystems of their growing regions including environmental and climatic variations, thus ensuring atleast sustainable level of output even in bad years.

Rice occupies 1.64million hectare area in Jharkhand with production of 3.98million tons and productivity 2423 kg/ha during the year 2020-21. (Source: Agriculture Department, Ranchi, Jharkhand). In 2013-14 the total area covered by rice crop in Jharkhand was 1.35 million ha. 30 percent area under rice is occupied by hybrids, 49 percent high yielding varieties and 21 % by traditional rice varieties in the state [7]. In Ranchi district Area under high yielding varieties is 88000 ha and in hybrid varieties 80000 ha. (Source: District Agriculture Office, Ranchi)

In Jharkhand rice is an integral part of its tradition. It is a symbol of cultural identity of the state. There are number of rituals and ceremonies related with the cultivation of rice. This crop is cultural sole of state and various festivals like Ero-Sim, Aouba before starting seed sowing, Herang and Rohini during seed sowing, Baha festival before flowering of rice and Maghe just after the harvesting of paddy crop are associated with various growth stage of crop. People in Jharkhand celebrate Navakhani after harvesting of upland paddy (GodaDhan&Gondali).

Jharkhand has a rich diversity of indigenous rice varieties. Gene Campaign, an NGO, has been working on conservation of agro-biodiversity rice and other crops since 1993. Traditional varieties of rice are being collected from Jharkhand and they have reported 1048 varieties of paddy during year 2006-2007. 560 varieties of paddy were from Ranchi district alone. Central Rainfed Upland Rice Research Station (CRURRS), Hazaribagh, Jharkhand, a Regional station of ICAR-National Rice Research Institute, Cuttack, identified 600 rice varieties from Jharkhand. These traditional rice varieties have different special characteristics like insect-pest resistant, flood and drought resistant, nutritional and medicinal properties etc. (Table 4)

About 300 varieties of scented rice were grown in respective state before the era of high yielding varieties. After green revolution the high yielding varieties have replaced the indigenous varieties in every part of the country. Despite being very high in nutrition and comprising numerous qualities, low yield and poor marketability of indigenous varieties has forced the farmers to shrink the net shown area of these varieties and adopt HYVs having considerably low nutrition.

Table 4: Traditional Rice Varieties of Jharkhand with their Specific Characteristics

Sl. No.	Specific Characters	Traditional Rice Varieties
1.	Short Duration and drought tolerant	Chennagora, Dani gora, Goindi, Hanskalma, Hendimuri, Kariagora, Punaigora and sarpagora
2.	Long duration and flood tolerant	Agnisal, Baghpanjar, Chitrabhog, Dhaniaphool, Gangajuli, Hazarimehika, Tulsiketki, Tilasair, Tulsimanjar, Zohinga
3.	Disease Resistant	Agni sal, AmbaDhopa, Barahasal, Bhodu, Chenna Gora, Dahiya, Haliguri, Hardiphool, Kalajeera and Lakra
4.	Insect Resistant	Balagora, BarkaDahiya, BarkaDhusri, Barkagora, Dahnigora, Karhaini, Karmisal, Kherkakhuchi, LalDhan
5.	Aromatic	Bhantaphool, Chandanphool, Chankachoor, Dhaniyaphool, Gobindbhog, Hardiphool, Kalajeera, Kapoor bhog, Kalazoha, Manhariphool, Vastabhog, Jeeraphool, Zohakajal
6.	Medicinal	Karhaini, layacha, Gudna, Danigora, Karanga

Source: Community gene seed bank, Gene Campaign, BAU, Ranchi

Keeping the above facts in view, KVK, Ranchi has started a new campaigning conservation and promotion of traditional rice varieties since 2013 in collaboration with Protection of Plant Varieties and Farmers Right Authority (PPVFRA). During this campaign, KVK has identified 213 varieties of indigenous rice which have specific characteristics and sent it to PPVFRA, New Delhi for registration in the name of respective farmers. Out of these, 39 farmers (Table 5) have received their certificates as on date. KVK Ranchi with other Four KVKs of Jharkhand jointly received first prize for special contribution in protection of traditional varieties at Koraput, Odisha during a national seminar in 2015.

Table 5: List of Registered Farmer's Varieties and their Distinct Characters

Sl. No.	Registered Farmer's Varieties	Distinct Characters by which farmers' varieties got certificate of registration under PPV & FRA
1	TewanDhan	Decorticated grain:Length : Medium
2	Barabali	Spikelet:Colour of stigma : Purple; Stem : Anthocyanin colouration of nodes: Present; Panicle: Awns: Present
3	Neta Kalani	Flag Leaf : Attitude of blade (Late Observation) : Erect; Spikelet : Colour of tip of Lemma: Purple
4	BageriSona	Panicle: Awns : Absent
5	Safed Lalak	Leaf Pubescence of blade surface; very strong
6	Lauhonchi	Leaf Auricles : Absent
7	Sendoosal	Panicle : Curvature of main axis : Drooping
8	Digambar Dhan-1	Panicle : Attitude of branches : Erect to semi-erect
9	TulsiManjar	Lemma : Anthocyanin colouration of apex : Very strong; Panicle : Length of main axis : Very long; Spikelet : Colour of tip of lemma : Black
10	ChhotaDahiya	Decorticated grain :Colour : Variegated brown
11	Barhabali	Leaf :Colour of ligule : Light purple
12	HadrasalDhan	Decorticated grain : Width : Broad

13	KodhaPhool	Decorticated grain :Colour : Dark Brown
14	Bacha Kolma	Leaf : Anthocyanin coouration of auricles : Purple; Stem : Anthocyanin coouration of nodes : Present; Spikelet : Colour of tip of lemma : Purple; Spikelet : Colour of stigma : Purple
15	Goda	Panicle : Awns : Present
16	Balamsar	Spikelet : Density of Pubescence of lemma : Strong
17	Rajnigandha	Leaf :Colour of ligule : Purple; Spikelet : Colour of stigma : Purple; Stem : Anthocyanin colouration of nodes
18	Kolhinkhosa	Spikelet :Colour of tip of lemma : Purple
20	Hajrakhuta	Leaf : Pubescence of blade surface : Strong; Panicle : Exertion : Well exerted; Decorticated grain : Width : Broad
21	HarikhuntaDhan	Panicle : Awns : Absent
22	Lalsita Sal	Leaf : Pubescence of blade surface : Very strong
23	TulsiMukul	Lemma : Anthocyanin colouration of Apex : Very Strong
24	Dev Dhan	Spikelet :Colour of tip of lemma : Purple
25	Sita Sal Dhan	Panicle : Awns : Absent
26	BaraunGodaDhan	Panicle : Length of main axis : Short
27	JeeraBhog	Flag Leaf : Attitude of blade (late observation) : Deflexed; Panicle : Curvature of main axis: Dropping
28	ArakhutaDhan	Leaf : Auricles : Absent; Flag leaf : Attitude of blade (early observation) : Horizontal; Spikelet : Colour of tip of lemma : Yellowish, Sterile lemma : Colour : Red, Decorticated grain : Length : Long shape (in lateral view) : Extra Long slender
29	Charka Dhusri	Panicle exertion mostly exerted 43 of 2017
30	BadkaDhan	Lemma : Anthocyanin coouration of apex : Strong; Panicle : Length of main axis : Strong Panicle : Awns : Present, Decorticated grain : Colour : Dark Brown
31	Nanhiya	Panicle : Attitude of branches : Semi-erect
32	NagrabaliDhan	Panicle : Awns: Present
33	Sursuriya	Presence of stem anthocyanin colouration of nodes; Acute leaf colour of ligule; Light purple leaf anthocyanin coouration of auricles
34	DahnigodaDhan	Medium panicle length of main axis
35	Safed Hambala	Coleoptile couour : Purple; Presence of stem anthocyanin colouration of nodes; Broad decorticated grain width
36	SonagutiDhan	Medium lemma; Anthocyanin colouration of apex; Broad decorticated grain width
37	Sufal Dhan-1	Absence of panicle awns; High endosperm content of Amylose
38	JerengDhan	Absence of panicle awns
39	LalMotaDhan	Broad decorticated grain width
40	Meghjawain	Spikelet colour of tip of lemma is black

Source: www.plantauthority.com

Short grain scented rice of Jharkhand: Scented rice is being grown in the Indian Subcontinent since the times of Susruta [200 BC (c.400BC-eds.)]. Later (circa 800-900 AD) a large number of aromatic and medicinal properties of rice have been mentioned in *Charak*

Samhita and *Kashyapiyakrishisukti*. In *Charak Samhita* aromatic rice is termed as Mahasali, Sugandhaka and Promodaka. In the 9th century Kashyap mentioned that Sali, Kalma, Smbhaka and Vrihi are the types of scented sub group. In ancient era scented rice was favourite of kings and popular in royal families as well as common people. Scented rice varieties have always had a special place in the country due to its unique taste and aroma.

Scented rice is classified into three types on the basis of grain morphology. Long grain type which is usually longer than 6.2 mm, medium graintype which is approx. 2.1 to 2.9 mm and short grain type which is less than twice as long as it is wide. Although, globally popular aromatic rice varieties are mostly long grained, majority of indigenous aromatic rice varieties in India are small and medium grained [8]. These varieties are highly thermo-photosensitive. Scented rice possess aroma in their plant parts and grain also. Molecular study revealed that aroma arose as a mutation in normal rice in the BAD 2 gene. Apart from aroma these rice have good texture and are sweet in taste. Some varieties have medicinal values too. Though, scented rice is found in almost all parts of India, Eastern states, North Eastern States and North Western States have a large number of such varieties. Rice grown in the Eastern and North Eastern states like West Bengal, Orissa, Chattisgarh, Bihar, Jharkhand, Assam, Manipur etc. are very short fine grained and highly scented (Table 6). North Western states like Punjab, Haryana, and Western UP have long grained scented rice known as 'Basmati'. Basmati rice is the premium grade of traditional rice. India is the largest producer and exporter of Basmati rice. India makes up 65% of the export in the world market. Rice (including Basmati and Non- Basmati) occupy the major share in India's total cereals export with 95.7% during the year 2019-20 (apeda.gov.in). The country has exported 50, 40,707.75 MT of Non-Basmati Rice to the world for the worth of Rs. 14,364.64 crores (\$2,014.59 million) during the year 2019-20. As per Indian Agricultural Research Institute (IARI) and APEDA varieties such as Kalanamak, TilakChandan and Jeerabati (Uttar Pradesh), Kalajeera (Orissa), Katrani (Bihar), Ambemohar (Maharashtra), Gobindbhog and Badshahbhog (West Bengal), Dubraj, Badshahbhog and Jawaphool (Chhattisgarh) and Kalajoha (Assam) have been identified which could be harnessed and developed for their export potential [9].

Table 6: List of Popular Short and Medium Grained Scented Rice in India

Sl. No.	Name of State	Heirloom varieties of Scented Rice
1.	Assam	Joha rice, Prasad bhog, Tulsibhog, Kalajeera etc.
2.	Bihar	Gopal Bhog, Sonachur, Shamjeera, Katarni, Kanakjeera etc.
3.	Chhattisgarh	Dubraj, Vishnu Bhog, JauPhool, Chinnor 1,2, Elaychi etc.
4.	Jharkhand	Tulsimukul, Jeerabhog, Rajnigandha, Bhutku, Tulsimanjar etc.
5.	Manipur	Chak-hao
6.	Orissa	Dubraj, Thakur bhog, Kala jeera etc.
7.	Uttar Pradesh	Kalanamak, Dhaniya, Hansraj, Ramjawain etc.
8.	West Bengal	Badshahbhog, Kala jeera, Tulsibhog, Govindbhog, Sitabhog etc.

Scented rice varieties are highly location specific hence each state has its own special variety of scented rice. One more popular short grained black scented rice of Manipur 'Chak-how' has medicinal and nutritional value. It protects from cancer and soothes inflammation due

to allergies and asthma. The rice gets its dark black or purplish colour because it is rich in anthocyanins, which are powerful antioxidants. The rice contains more vitamin B, niacin, vitamin E, calcium, magnesium, iron, and zinc compared to white rice. Rich in fibre, the grain has a sweet and slightly nutty taste. Recently Manipur has got GI for 'Chak-how' in the name of 'Manipur Black Rice' (www.outlookindia.com).

More than 1000 indigenous rice varieties are native to Jharkhand but very few of them are having scented rice. Majority of scented rice found in Jharkhand are short grained and some are medium grained. Black husk scented rice varieties are more common than white husk varieties. It is more nutritious due to presence of anthocyanin as antioxidant and iron content. Most of the scented rice varieties are tall (155 cm), Long duration (135 to 155 days) suitable for Lowland. Most of the varieties are prone to lodging but some varieties like Bhutku are lodging resistant. In Jharkhand farmers presently grow scented rice for their own consumption and ceremonial purposes. The short fine grain scented rice is sticky, aromatic and delicious to make sweet dishes like Kheer, Paysam etc. The rice is also consumed as steamed rice and the throat gets full of fragrant breeze once eaten.

Table 7: List of Indigenous Scented Rice Identified by KVK, Ranchi

Sl. No.	Name of Scented rice	Grain type	Suitable land for Cultivation
1.	Safed Lalak	Short coarse grain	Upland
2.	Thadmaini	Medium coarse grain	Midium Land
3.	Lal Sita Sal	Medium coarse grain	Midium Land
4.	DigambarDhan 1	Medium coarse grain	Midium Land
5.	TevanDhan	Short Coarse grain	Midium Land
6.	Bachakolma	Medium coarse grain	Low Land
7.	Rajnigandha	Short fine grain	Low Land
8.	HajrakhuntaDhan	Medium coarse grain	Low Land
9.	JeeraBhog	Short fine grain	Low Land
10.	TulsiManjar	Short fine grain	Low Land
11.	Hadrasal	Medium coarse grain	Low Land
12.	Lauhonchi	Short Coarse grain	Low Land
13.	Kolhinkhosa	Medium coarse grain	Low Land
14.	TulsiMukul	Short fine grain	Low Land
15.	Mekhjawain	Medium Fine grain	Low Land
16.	DhaniyaBhog	Short Coarse grain	Low Land
17.	Bhutku	Short fine grain	Low Land

KVK Ranchi has identified some indigenous scented rice (listed in Table 7) which are cultivated in different topography of Jharkhand. Out of the seventeen varieties of scented rice mentioned above, fifteen varieties are registered under PPV & FRA and two varieties namely DhaniyaBhog and Bhutku are under process of registration. Bacha Kolma, Rajnigandha, Meghjawain, Tulsimukul and TulsiManjar are black husk rice and rich source of micro nutrient such as iron and zinc. DhaniaBhog, is neither slender nor small, it has round grained, unusual looking, aromatic rice has a unique flavour and strong aroma is preferred for making Biryani. Bhutkuis one of the most preferred scented rice because it has the potential to give

high yield like high yielding varieties. Jeerabhog is a variety which is similar to a very popular scented rice of Tamil Nadu 'Jeeraga Samba'. The grain of the rice is very tiny and it gets its name due to its resemblance to Cumin seeds, also called as Seeragam/Jeera in Tamil. Like Jeeraga Samba, JeeraBhog has a very distinct taste and aroma, preferably used in preparation of sweet dish like Kheer and Paysam. Many of the scented rice varieties are having potential to get commercialized and could fetch high premium value in the national and international markets.

IV. KVK INTERVENTIONS FOR REVITALIZING INDIGENOUS SCENTED RICE VARIETIES FOR DEVELOPMENT OF SUSTAINABLE LIVELIHOOD TO THE TRIBAL FARMERS

Since introduction of high yielding varieties (HYVs) during green revolution era native land races have been rapidly squeezed out from production chain (Sharma *et al.*). A number of traditional rice varieties consumed prior to the Green Revolution have now become extinct. A report published in Newspaper, The Hindu stated that, only 6000 traditional rice varieties are now in existence and not all of these varieties are under cultivation. India has lost more than 1 lakh varieties of indigenous rice after the 1970s that took several thousand years to evolve. Expansion of area under HYVs for enhanced production and productivity has led to fast shrinking of area under indigenous rice varieties which is a major cause of genetic erosion.

Keeping the above facts in view, KVK, Ranchi has been working for conservation and promotion of traditional crop varieties since 2013 in collaboration with Protection of Plant Varieties and Farmers Right Authority (PPV&FRA). The programme was very successful in terms of collection and registration of farmers' varieties but with respect to immediate economic benefits to the farmers there was little scope in near future. Most of the farmers of Ranchi district are marginal and small and the socio-economic condition is very poor, to meet both end needs they have to sell their agricultural produce on daily basis. In view, KVK took an initiative with financial support from NABARD, Ranchi to stabilize and promote existing livelihoods portfolio of the farmers of Ranchi district who were involved in PPV&FRA programme. Agriculture is the mainstream livelihoods activity for farmers; KVK has played special focus on sustainable production of indigenous scented rice through maiden project started in the year 2016.

Ten indigenous rice varieties namely Jeerabhog, Tulsimanjar, Tulsimukul, Prasad Bhog, Bhutku, DhaniyaBhog, Mekhjawain, Rajnigandha, Saraikela and Panisayir were selected by KVK under the project with an aim of making it the main source of income to farmers of Ranchi district. Out of ten varieties eight varieties of rice were aromatic rice. Most of the selected varieties were registered on farmers name under PPV&FRA through KVK in 2016 itself. 100 farmers of five blocks were selected under this project. Out of 100 farmers those five farmers who had rightful ownership of the chosen varieties were selected as lead farmers under this project. As indigenous rice is location specific so to maintain the quality, locations were selected in such a way that the varieties pertained to that specific location and where being cultivated there in small pockets. Initially awareness programs were organized in five blocks namely **Namkum, Silli, Mandar, Bero and Chanhoof** Ranchi district to motivate farmers for restarting cultivation of traditional rice varieties. Crux of these programs

was to inculcate the faith among farmers that cultivation of indigenous rice varieties will fetch them higher price over the period.

Table 8: Details of Varieties Chosen for Promotion

Sl. No.	Indigenous rice varieties	Location	Characteristics
1.	Rajnigandha	Soba, Burmu, Ranchi	Aromatic rice with small grain type
2.	Tulsimukul	Piska, Silli, Ranchi	Long duration aromatic rice with small grain type suitable in flood condition
3.	Jeerabhog	Losera, Silli, Ranchi	Aromatic rice with small grain type
4.	Prasad Bhog	Hakedag, Silli	Aromatic rice with small grain type
5.	Tulsimanjar	Lundari, Chanho, Ranchi	Aromatic rice with medium long grain type
6.	Saraikelela	Jariya, Bero, Ranchi	long grain type
7.	Panisayir	Jariya, Bero, Ranchi	long grain type
8.	BhutkuDhan	Lundari, Chanho, Ranchi	Aromatic rice with small grain type
9.	Dhaniyaphul	Gurgurjari, Mandar, Ranchi	Aromatic rice
10.	Mekhjawain	Ratu, Ranchi	Aromatic rice with small grain type



1. Farmer's participatory varietal screening: Multi location varietal screening trials were conducted at five locations of lead farmer's field. Farmers were trained in organic rice cultivation. The main aim was to deliver the same quality of the scented rice as well as reduction in cost of cultivation.



Training and formation of seed producer group

The scented rice varieties have abilities to maintain soil health, give sustainable yields and fetch more profit using less input, as their cost of production under good organic management practices is low. After proper training each lead farmer conducted a varietal screening-cum- package of practices standardization trial in 0.5 acre of his land. All the critical inputs like seed, bio-fertilizers, bio control agents, see weed extracts, pheromone traps etc. were used as part of organic crop management. Pre- and post-harvest data of all the varieties were recorded and evaluated. On the basis of field performance and market preference two scented rice varieties TulsiMukul and Bhutku were given better yield than others. These two varieties showed higher yield, lodging resistance and wider adaptability too. These varieties were selected for further multiplication as it has a potential to commercialize seed production.



Nursery Raising of Selected 10 Indigenous Varieties

2. Improved package and practices for traditional scented rice varieties

- **Selection of land:** Most of the scented rice varieties are long duration and suitable for low land areas. The area selected for cultivation of scented rice varieties like Bhutku and TulsiMukul was lowland as these varieties mature in 135 to 150 days after sowing. In below average rainfall condition too, these varieties performed well in lowland at

Silli and Tamar block of the district. As these soils get deposited from the forest uplands and they are very fertile in nature.

- **Agronomic practices**

- **Seed rate:** 12-15 kg/ha of pure seed was used for sowing a hectare of land by following single plant transplanting method, which proved good for growth and greater biomass production.

- **Seed treatment:** Seeds were treated with Beej Sanjivani (1:1:2, Cow urine: cow Dung: water is mixed together and decomposes for 7-10 days in clay pot). Before sowing, seeds dipped in Beej sanjivani solution (1 lit in 750 ml of water) for 12 hrs and such solution is required for 1.0 kg of seed. Floating chaffy seeds were discarded and heavier seed which settle at the bottom were selected. These seeds were kept in jute bag in moist condition for sprouting. After 24 hrs seeds will sprout, this can be shown in nursery beds.

Seedling treatment with PSB (Phospho- Solubilizing Bacteria) leads to strengthen root system so that crop with 150 cm height can resist lodging problem. Suspension of one kg PSB in 10 litres of water for treating of seedlings for one acre was required. Seed and seedling can also be treated with *Trichoderma viride*.

- **Sowing Time:** For nursery rising seeds should be sown in the month of June.

- **Nursery rising:** One-tenth part of the main field is enough to raise healthy seedlings. The field was ploughed twice or thrice under dry condition along with incorporation of 500 kg well decomposed farm yard manure (FYM) with one kilogram *Trichoderma viride* in an area of 1000 m². Thorough puddling followed by leveling is required. Thereafter, divide field in convenient size of beds to have a better control on irrigation and drainage. Sprouted seeds should be broadcasted uniformly in each bed. Irrigate nursery in evening. Hand weeding required at 10 days after sowing (DAS). Prior to transplanting in main field, seedling root should be treated with PSB solution (2.5 kg per 25 lit of water solution is required for seedling treatment for 1 ha) for 30 minutes.

- **Main field preparation:** Green manuring with *Sesbania spp.* is very good for soil conditioning. It should be trampled at 10 days prior to transplanting to allow proper decomposition. 5 ton *Trichoderma viride* seeded Farm Yard Manure need to be incorporated in main field at the time of ploughing along with Karanj cake @1 qtl per acre. Application of liquid organic manures like Sanjivani, Sasyagavya, Panchgavya at 10 days interval is required to compensate the nutrient requirement.

- **Transplanting:** 20 days old seedlings should be transplanted with row spacing of 25 cm. Single plant transplanting method should be followed for better growth of each single plant.

- **Incorporation of azolla:** Azolla has to be broadcasted after 10 days of transplanting. It suppresses growth of associated plants (weeds) and encourages crop growth.
- **Water management:** In Jharkhand paddy is cultivated in rainfed condition only. In case of limited rain, irrigation should be done at the time of tillering, anthesis and grain filling stage of scented rice field.
- **Weed management:** Cono-weeder should be used for mechanical incorporation of weeds for 2 to 3 times at 10 days interval starting from 10-15 DAT. One round hand weeding is also required at 20 DAT for removal of weed between the plants.
- **Plant protection measures:** In organic cultivation, precautionary measures are more important and effective than curative measures for disease, pest control. Funnel T Trap with lure of *Scripophaga Incertulus*, Yellow sticky trap, Blue Sticky Trap, Azadiractin 1500 ppm, Pseudomonas, *Trichoderma viridae*, *Beauveria bassiana* can be used as precautionary measures. The egg cards (*Tricho* cards, *Trichogramma chilonis*, *Trichogramma japonicum*) containing 1,000 parasitized eggs are to be stapled to the underside of the leaves at 100 points ha⁻¹ uniformly distributed across the field. *Trichoderma viride* 3.0 g per litre water can be sprayed for 2-3 times starting from 20DAT at an interval of 15 days to prevent different diseases.

A bio pesticide Dasparni (A botanical made from extracts of 10 different types inedible leaves found in the locality e.g. *Vitex negundo*, *Lantana camara*, *Argemone maxicana*, *Adhatodavasika*, *Calotropis gigantean*, *Pongamia pinnata*, *Anona squamosa* etc.) should be sprayed at 15 days interval starting from 20 days after of transplanting (DAT) to control sucking pest.

- **Harvesting and threshing:** Harvesting should be done when the panicles are mature (about 70%) and the straw has just turned yellow. For the purpose of seed, harvesting should be done from the middle part of the field. Harvested paddy should be dried and cleaned properly for better & long time storage.

V. SEED PRODUCTION OF POTENTIAL VARIETY

Without quality seeds, the output would be very less despite of huge expenditure on other agricultural inputs. Hence, after initial work for screening and standardization it was necessary to produce quality seed to facilitate further expansion of area under these varieties. One Seed producer group in each selected village and trained in seed production of paddy. After proper training farmers were engaged in participatory seed production programme. Seed production was taken in 12.75 acre land against targeted area of 5 acre due to increasing demand among stakeholders.

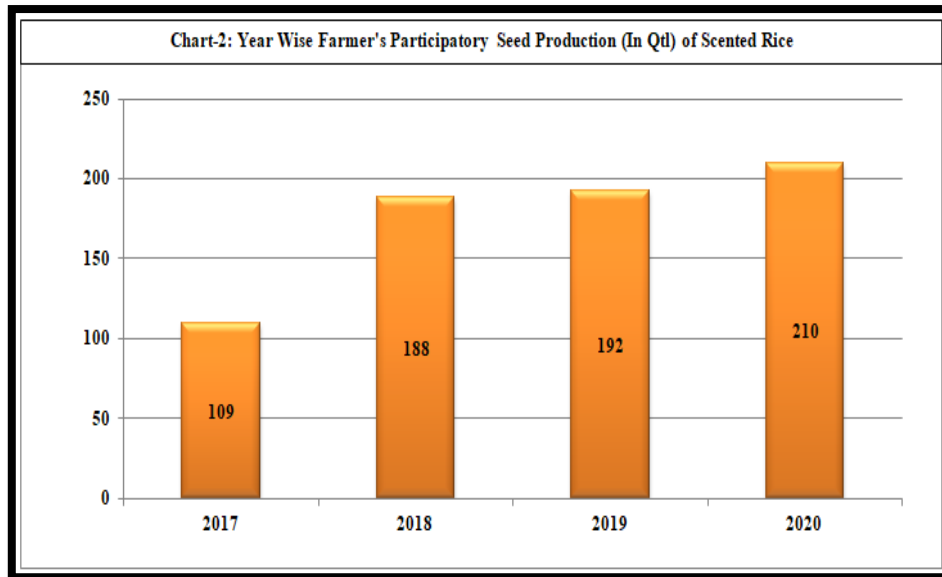


Seed Production of Tulsi Mukul at Farmer's Field



Processed Seed of Tulsi Mukul Ready for Sale

All the quality control measures were followed for pure seed production. Specially roging was done 3 to 4 times for getting pure seed and avoids any type of mixture in seed. 109 qtl seed of Bhutku and Tulsi Mukul seed were produced in very first year (2017-18). To provide market to farmers and expansion in area under scented rice production KVK purchased seed from farmers and processed for further sale and production. In year 2020-21, 210 qtl seed of scented rice was produced under farmer's participatory seed production programme as shown in Chart-2. Farmers expressed their reaction on the palatability of straw of these varieties as the straw was preferred by cattles over the straw of HYVs.

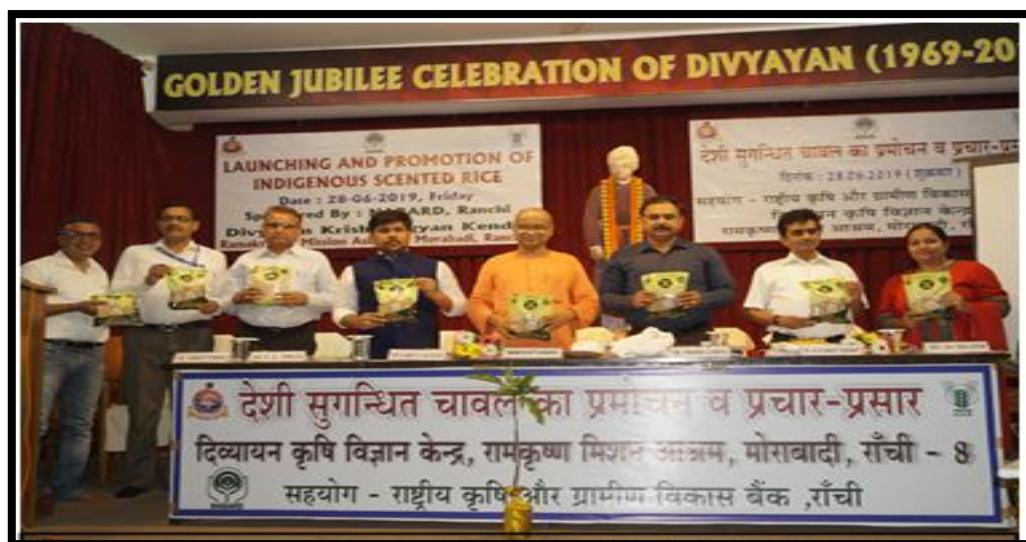


Commercial production and area expansion of indigenous scented rice: KVK formed five groups (One at each village) for commercial production of scented indigenous rice and to establish proper marketing channel.



Bhutku Rice Field under Commercial Production

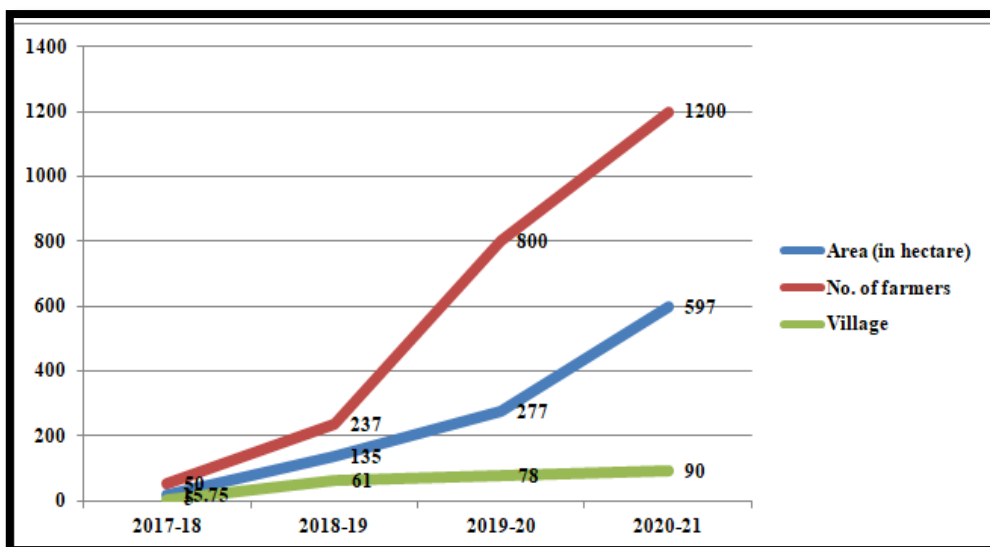
A survey was done by KVK to assess the demand and supply of scented rice in Ranchi. It was observed that indigenous scented rice is not being marketed however rice with same phenotype with artificial aroma is being sold on name of Sonachur between ₹ 80-100 per Kilogram. Therefore, indigenous scented varieties with naturally good taste and aroma will have great scope in organized market. Farmers were trained in commercial production, milling and packaging of scented rice. All supports like seed, bio fertilizers, bio agents etc. for production, milling facility, automatic sealing machine, and triple layer perfectly designed rice packet were given to the group for successful marketing of scented rice. Farmers of the group were visited ICAR- National Rice Research Institute, Cuttack, Odhisa for better exposure and skill training.



Promotion and Launching of Scented Rice Packet

In 2017 -18 various types of promotional activities were conducted by KVK like Kisan Mela, Kisan Gosthi, and other promotional program on scented rice for wide publicity of the organically grown indigenous scented rice produced by farmers. The steps being taken to tie the farmers with the market so that they would get good return and will be encouraged to continue the practice. KVK has given marketing support to scented rice farmers and provided place in well-established sale counter, which is situated in the heart of the Ranchi city for selling of their rice. Today demand is very high of this scented rice due to its unique aroma and taste. Many groups inspired from the intervention also opted these varieties and started their cultivation in adjoining districts like Gumla, Khunti etc. with the guidance and seed from KVK, Ranchi. The trend of increasing in area, number of farmers and villages covered is shown in chart-3.

Chart 3: Showing Increase in Area, no. of Farmers and Villages Covered Year on Year Basis under Scented Rice Cultivation



Final Product Ready for Sale

The benefit of cultivation of indigenous scented rice is evident from farmer's income getting doubled *i.e.* fetching Rs. 25- 30 per kg for indigenous paddy as compared to Rs.15 per kg for HYVs (Table 9). Now they are getting premium price for their quality product. At present, farmers are selling scented rice at Rs.80/- per kg after milling and packaging. There are two major benefits to the scented rice growers like 47 % saving in input cost and getting 42 % higher price than other paddy.

Table 9: Comparative Study on Production between Scented variety and HYV Paddy

Sl.No.	Particulars	Scented Rice	Improved variety
1.	Cost of cultivation (Rs. /acre)	14050.00	26313.00
2.	Yield (qtl/acre)	12.00	20.00
3.	Selling Price (Rs. /qtl)	3000.00	1750.00

4.	B: C Ratio	2.56	1.33
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VI. WAY FORWARD

Cultivation of Hybrid paddy deserves continuation for economic and food security. This is essential for GDP growth and economic empowerment of farming community as rice is providing direct employment to 70% people in rural areas in the country. So it is important to explore a viable economic use of traditional varieties which will prevent these from getting extinct as well as help in maintaining cultural heritage. Though the diversity of small grained scented rice is un-explored and researchers give little emphasis on them, there is still a great scope to improve their ideotype, better yielding and molecular aspects[10].

Research and extension for traditional rice varieties having marketing potential should be taken into consideration and their inherent qualities may be exploited for value addition. As the cultivation of traditional rice varieties is dependent on the price received, GI (Geographical Indication) tagging will help in realizing premium prices and attract more farmers to traditional rice cultivation [11].

VII. CONCLUSION

Since traditional rice varieties are well adapted to marginal lands requiring less inputs, it gives an opportunity to reintroduce the scented rice varieties, in particular, for sustainable production with local resource based low-cost organic cultivation. Farmers who are involved in organic production should be encouraged through different Govt. schemes initially. For better pricing of traditional rice varieties focus should be given on characterization and evaluation of nutritional and medicinal properties of these particular rice varieties. Farmers who are already involved in scented rice cultivation have become self-sufficient in seed because these farmers are saving their seeds from every year's crop and using it in the next season. Seed production of indigenous rice variety is also helping in restoring back the lost biodiversity. Pure seed is very critical input for increasing productivity and quality of scented rice. Cultivation of indigenous varieties by using balanced natural resources is efficiently strengthening soil as well as restoring the depleting ecosystem.

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