

## **IARI BEST PRACTICE**

### **1. Title of the Practice**

Development of crop varieties/hybrids for food, nutritional and livelihood security

### **2. Objectives of the Practice**

IARI has employed pre-breeding, genomics assisted gene mapping, introgression and pyramiding of genes/QTLs by using molecular marker assisted breeding to develop varieties and hybrids that are required for enhancing farmers' income, reducing pesticide usage and enhancing nutritional quality of the products. Objectives are as follows:

- Development of crops varieties with higher yield for increasing the income of farmers
- Development of crop varieties with innate tolerance to abiotic and biotic stresses for minimizing input cost and reducing pesticide usage
- Development of varieties/hybrids with enhanced nutritional quality for overcoming hidden hunger in India

### **3. The Context**

To meet the global food demand in 2050, agricultural production must be increased by 60 per cent. The Indian Agricultural Research Institute, the seat of green revolution, continues its' efforts to ensure food and nutritional security of the Nation, and enhance the profitability of 55% of the India's population involved in agriculture sector. The institute has deployed conventional and genomic tools for development of new high yielding and abiotic and biotic stress resistant crop varieties to enhance the productivity, profitability, environmental sustainability and climate resilience of agriculture. The genomics-aided precision breeding programmes resulted in the accelerated development of 12 varieties and hybrids in field crops, 14 in vegetables and 6 in fruit crops with improved yield, drought and heat tolerance, resistance to major diseases, quality and adaptability. IARI wheat varieties contribute 60% of the Nation's wheat production. Four new wheat varieties have been released including a heat tolerant wheat variety HD 3298 rich in iron and protein. IARI Basmati rice varieties occupy 98% of the basmati grown area of the country and contribute to Rs 30,000 crores of export earnings every year. This year, IARI has released an early maturing Basmati rice variety Pusa Basmati 1692, which matures in 115 days. IARI has developed wheat varieties HD3298 and HI1633 with high iron, Zinc and protein content to address the micronutrient malnutrition problem in the Country. This has huge advantage as farmers have lots of time between harvest of rice crop and wheat sowing, they can properly use the residue and need not burn it. Further, it saves almost 5-6 irrigation, which is sufficient for next wheat crop

production. On the World Food Day 2020, Hon'ble Prime Minister of India released three biofortified varieties developed by IARI. In lentil, two salt tolerant varieties have been released for cultivation in salt affected areas of the country. High yielding mustard varieties of IARI occupy about 50% of the mustard grown area of the country and thus contribute to reduction in edible oil import bill. This year, IARI has released Pusa Mustard 32, a low erucic acid content variety, with an average oil content of 38% and seed yield of 2.71 t/ha.

#### 4. The Practice

IARI has been serving the country by developing appropriate technologies through basic, strategic and need-based research resulting in crop improvement and agricultural productivity in harmony with the environment leading to the Green Revolution. For development of varieties and hybrids, IARI employs the following approaches:

- 1) Identification of donor parents for various traits by precision phenotyping of germplasm and wild species for traits of economic values
- 2) Mapping of genomics regions associated with traits of interest
- 3) Molecular marker assisted breeding to develop varieties/hybrids
- 4) IARI station trials to assess the performance of the varieties
- 5) Multilocation trials at different agroecological zones of India conducted by All India Coordinated Research Project
- 6) Identification of best performing variety
- 7) Variety release by the Central Variety Release Committee (CVRC) at the national level, and State Variety Release Committees (SVRCs) at each state level.
- 8) IARI maintains nuclear seed and produces breeder seeds
- 9) Department of Agriculture & Cooperation receive request for the breeder seeds from different government agencies (National Seed Corporation and state seed corporation) involved in seed production, certification and supply to the farmers, and IARI supplies required breeder seeds.
- 10) IARI also licenses the varieties to different private industries and farmers producer organizations
- 11) National Seed Corporation, state seed corporation, private industries and farmers producer organizations produce seeds and supply to the farmers.
- 12) IARI also produces truthfully labelled seeds, and supplies to the farmers directly.

IARI has released 88 Varieties & Hybrids in field and horticultural crops during the last 5 years. **107 technologies** were commercialized to **301 industry** partners, and earned a license fee of Rs.**418.26 lakhs**

**Field crops = 40**

**Vegetables = 37**

**Fruits = 11**

- **IARI Wheat varieties are grown in 60% of wheat grown area of the Nation.**  
IARI wheat varieties such as HD2967 and others are cultivated in nearly 15 mha and contribute approximately 60 million tons of wheat to the Nation's granary. Additional income from HD2967 in 2016-17 alone was Rs. 20,141 crores (Source: IARI Technologies for Farmer's Prosperity)
- **IARI Basmati Rice varieties are grown in 91% of Basmati Rice area of the Country. IARI Basmati rice varieties Pusa Basmati 1121, Pusa Basmati 1509, Pusa Basmati 1401, and Pusa Basmati 1 contribute about Rs. 28000/- crores export earnings every year.**

Variety	Area (lakh ha)	% Share
PB 1121	9.4	46.6
PB 1509	5.27	26.2
PB 1	1.58	7.8
PB 6 (Pusa 1401)	1.7	8.5
PB 1637	0.36	1.8
PB 1718	0.07	0.3
Total - IARI Basmati Varieties	18.38	91.2
Other Basmati	1.73	8.7
<b>Total - Basmati Varieties</b>	<b>20.11</b>	<b>99.9</b>

**Source:** Basmati Crop Survey Report, *Kharif 2019 Vol.2*, APEDA, New Delhi

- **IARI mustard varieties occupy about 40% of mustard grown area in the Country.** IARI mustard and pulses varieties enhanced the farm production and thus contributed to reduction in import. Country is importing Double Zero Mustard Oil at present. However, IARI has developed Pusa Double Zero Mustard 31 variety which will contribute towards import reduction in due course. The basmati export earning of Rs. 28,000 crores annually from IARI varieties directly contribute towards compensation of import bill on edible oil.
- Two Mango varieties Mallika and Amrapali are grown on 232000 ha bringing prosperity to farmers in Jharkhand, Odisha, West Bengal, Telangana, Uttar Pradesh, Andhra Pradesh and Karnataka. Recently, institute has developed several varieties such as Pusa Surya, PusaArunima, PusaPratibha, PusaShressth, PusaLalima and PusaPeetamber with coloured peel and less sweetness targeting the export market. In 2018-19, Amrapali was exported to Dubai, Hong Kong and Malaysia from West Bengal and Uttar Pradesh. Mallika is exported to USA, parts of the European Union, UAE, Kuwait, Japan, Malaysia, Singapore and South Korea, while Gujarat is exporting it to EU countries along with Kesar 50 tonnes.

**Some of the unique varieties released by IARI during this period:**

- **Wheat HD CSW 18** - First variety bred in India for Conservation agriculture.
- **Pusa Double Zero Mustard 31**- First *Canola* type mustard variety in India.
- **Maize PusaVivek QPM 9 Improved** - Country's first provitamin-A rich Maize hybrid; High in provitamin-A (8.15 ppm), lysine (2.67 %) and tryptophan (0.74 %)
- **Wheat HD 3086** – licensed to 99 firms from 2015-2019 (overall licensed to 208 firms)

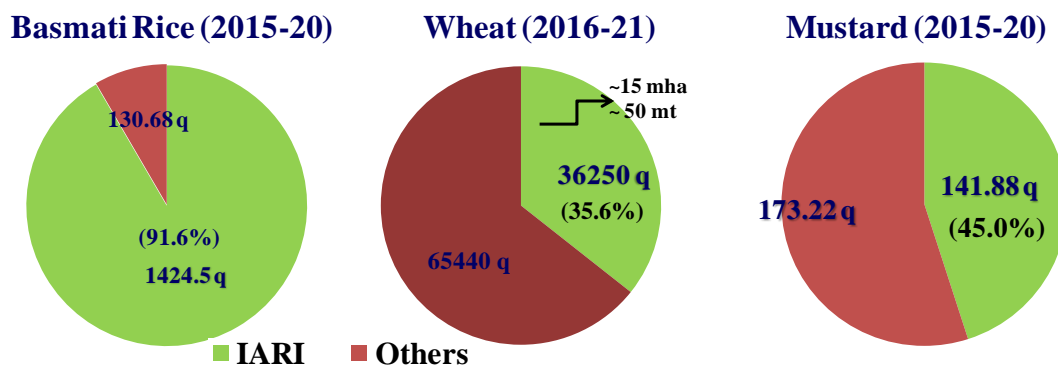
- **Wheat HD 3226** – licensed to 70 firms in 2019
- **Rice Pusa Basmati 1728** – licensed to 34 firms in 2018-19. Covering about 2 lakh ha.
- **Rice Pusa Basmati 1637** – licensed to 11 firms in 2018-19.
- **50 vegetable/flower crop varieties/ hybrid** have been licensed to 13 firms from 2015 onwards.
- IARI Pusa Basmati 1509 matures in 115 days with an average yield of 5 tons/ ha and possesses non-lodging and non-shattering habit. On account of being early, **it saves 6 irrigations**.
- The Institute has released 18 varieties/hybrids in vegetable and flower crops. In vegetable crops, two varieties each in brinjal (Pusa Hara Baingan 1 and Pusa Safed Baingan 1) and muskmelon (PusaMadhurima&PusaSarda), one each in okra (PusaBhindi 5), Chenopodium (Pusa Green), cucumber (Pusa Seedless Cucumber 6), long melon (PusaUtkarsh), round melon (PusaRaunak) and garden pea (Pusa Prabal), and two F1 hybrids, viz., one in bitter gourd (Pusa Hybrid 4) and one in sponge gourd (Pusa Shrestha) were released by Delhi State Seed Sub-Committee.
- In flower crops, six varieties were released by the State Seed Sub-Committee for Agriculture & Horticultural Crops, Govt. of NCT, Delhi. These have been notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Horticultural Crops in 2019. These were PusaMahak (rose), PusaBahar and Pusa Deep (marigold), PusaGuldasta and PusaSwet (chrysanthemum), and PusaSinduri (gladiolus). These varieties and hybrids are expected to benefit farmers and consumers.
- Pusa Pickling Cucumber-8 (DG-8) will secure yield of 80-85 t/ha (800-850/100 m<sup>2</sup>) during winter season (off-season: Nov.-March) under low cost poly-house. PusaShreyash (DS-17) of Summer Squash will provide 20.0-22.0 t/ha in winter season under poly-house.
- Pusa Snowball Hybrid-2 (KTH-DH-1) is the first doubled haploid based F1 hybrid. It has more uniformity as compared to the conventionally bred F1 hybrids 2
- Pusa Purple Cauliflower-1 (KTPCF-1) has intense purple colour and the pigmentation is present deep inside the bracts below the curd. The average anthocyanin concentration in the edible portion is 43.7mg/ 100 g of the edible portion. Average marketable curd weight is 0.76 kg.
- PusaRakshit (DTPH-60) of tomato is a first F1 hybrid of IARI for protected cultivation. Average fruit yield/plant is 15 kg/m<sup>2</sup>. The ripe red fruits have TSS 5.10 Brix and lycopene content 6.0 mg/100 g. Spinach variety PusaVilayatiPalak is short in duration and gives two cuttings with yield of 12t/ha. It contains high ascorbic acid, iron and calcium (65, 8 and 186 mg/100g respectively).
- PusaSunehari variety of Muskmelon is a first orange fleshed variety of Sarda melon and it will suitable for protected cultivation. Pusa Hybrid-3 (DCH 976) of cauliflower will help farmers to earn more as it will be harvested when demand continues to more but supply is lowered in the market. Its harvesting can be done in 2nd fortnight of December in Delhi condition with yield. of 37-39 t/ha.
- PusaManohari (Hybrid 8-11) of mango is a regular bearing a hybrid of Amrapali x Lal Sundari having field tolerance to mango malformation (10-15%). PusaDeepshikha (Hybrid 11-2) is a hybrid of Amrapali x Sensation having regularity in bearing. Pusa Seedless Pummelo-1 is India's first seedless white fleshed pummelo mutant having high juice recovery (41.13%). Grape Hybrid Pusa Purple Seedless were raised through embryo rescue, it is an extra-early berry ripening variety (75-80 DAFB) under sub-tropical region.

## 5. Evidence of Success

IARI employed cutting-edge science and technologies to develop several crop varieties with improved yield, quality and adaptability, resource management technologies, and pest and disease management methods, farm machineries, protected cultivation methods and food processing techniques for enhancing the input use efficiency, farm profit and environmental sustainability.

- IARI wheat varieties contribute nearly **60 million tons of wheat to nation's granary** worth **Rs. 80,000 crores annually**. **The total economic surplus generated from HD 2967 is estimated at Rs 81928 crores (at 2018 prices) during the period of past 10 years (2011-2020)**. Therefore, a large share of wheat grain produced in India comes through IARI varieties, thus contributing very strong towards food and nutritional security.
- Currently, the IARI **Basmati rice varieties account for 90% of the total foreign exchange (Rs. 29524 crores)** earned through export of Basmati rice amounting to Rs. 32,804 crores. **The annual economic surplus generated from PB1121 are estimated at Rs. 14707 crores during triennium ending 2018-2019 which is 12 fold more than the budget of IARI and 2 fold more than the entire ICAR budget during TE 2018-19. The earnings from PB 1121 are about 96% of the total expenditure of the entire NARES (Rs 15379 crores) during TE 2018-19.**
- About **48% of mustard grown area in the Country is cultivated with IARI varieties**. The total economic surplus generated from Pusa Mustard 25 is estimated at Rs 14323 crores (at 2018 prices) during the past 9 years (2010-2018), and was distributed between the producer and consumers in the ratio of 51:49. **The average surplus for TE 2018-19 was estimated at Rs 2919 crore and was allocated Rs 1499 crore to the farmers and Rs 1420 crores to the consumers.**

IARI varieties have very high demand from farmers and are widely cultivated in large areas as evident from the breeder seed indent as shown below:



Share of IARI varieties in the breeder seed indent of basmati rice, wheat and mustard.

IARI varieties were licensed to **187 companies for commercialization.**

S.No.	Name of Variety	No. of Companies
	<b>Pusa Basmati Varieties</b>	
1	PB-1637	11
2	PB-1718	19
3	PB-1728	15
	<b>Wheat varieties</b>	
4	HDCSW-18	3
5	HD-3086	52
6	HD-3117	1
7	CSW-18	1
8	HD-3226	70
	<b>Maize Hybrid</b>	
9	Maize PJHM-1	5
	<b>Mustard Varieties</b>	
10	Pusa Mustard 25, 26, 27, 28, 29, 30 & 31	2
11	<b>Vegetables (21 Varieties)</b>	8
	<b>Total number of companies</b>	<b>187</b>

IARI has contributed significantly for **Breeder Seed Production (quintals)** and supply to various agencies

Crop	2017-2018		2018-2019		2019-2020		Total	
	Indent	Production	Indent	Production	Indent	Production	Indent	Production
Paddy	241.8.0	233.25	240.20	271.49	243.26	298.05	<b>740.26</b>	<b>802.79</b>
Moong	26.00	13.40	5.71	4.80	9.45	80.19	<b>41.16</b>	<b>98.39</b>
Arhar	13.22	18.00	8.30	8.80	11.72	14.84	<b>33.24</b>	<b>38.06</b>
Wheat	4598.09	6176.60	5190.48	5428.47	5208.60	7020.13	<b>14998.30</b>	<b>18625.2</b>
Lentil	21.50	13.45	24.60	7.86	23.80	12.69	<b>69.90</b>	<b>034</b>
Chickpea	15.00	18.20	0	10.04	28.00	14.34	<b>28.00</b>	<b>42.58</b>
Mustard	29.74	54.66	31.34	53.16	40.89	54.17	<b>101.97</b>	<b>161.99</b>
Barley	1.00	3.00	1.00	1.00	1.00	1.00	<b>3.00</b>	<b>5</b>
Field Pea	11.50	17.50	4.10	4.10	0	0	<b>15.60</b>	<b>21.6</b>
Lathyrus	6.60	8.00	28.50	28.50	4.00	4.00	<b>39.10</b>	<b>40.5</b>
Pearl Millet	0.80	1.14	0.42	0.90	0.80	2.64	<b>2.02</b>	<b>4.68</b>
Sorghum	12.80	2.90	8.60	5.30	3.85	8.00	<b>25.25</b>	<b>23.18</b>
Vegetables	0	11.74	0	12.01	0	4.81	<b>0</b>	<b>28.56</b>
<b>Total</b>	<b>4978.05</b>	<b>6571.84</b>	<b>5543.25</b>	<b>5836.43</b>	<b>5575.37</b>	<b>7514.86</b>	<b>16097.8</b>	<b>19926.53</b>

In addition, IARI also produced **19722.65 quintals Certified / Truthfully labeled Seeds** and sold to the farmers directly.

## **6. Problems Encountered and Resources Required**

Development of crop varieties is technology, time and labour intensive activity and hence required adequate funding. Limitation of budget is one of the major problem. Adequate funding should be provided for varietal development, maintenance and seed production and supply to the farmers. The industries and export agencies have hugely benefited from IARI varieties, who can also support IARI research program through special funding under CSR or any other program.

## **7. Notes (Optional)**

Other universities can obtain breeding lines and donors developed by IARI for use in their breeding program

Other Institutes can also take breeder seeds from IARI, produce seeds and supply to the farmers of their region.