Biofortified Varieties: Sustainable Way to Alleviate Malnutrition

सत्यमेव जयते

Indian Council of Agricultural Research
New Delhi 110 001

भाकृअनुप
ICAR

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राधा मोहन सिंह
RADHA MOHAN SINGH

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कृषि एवं किसान कल्याण मंत्री
भारत सरकार
MINISTER OF AGRICULTURE
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GOVERNMENT OF INDIA

MESSAGE

Indian Agriculture has made impressive progress over the years and phenomenal growth has been observed in crop production. In the race of more production, due care was not given towards quality improvement, that has led to malnutrition which is caused by inadequate consumption of balanced diet. Malnutrition has emerged as one of the alarming problems especially in the under-developed and developing world. In India more than one-fifth of the population lives in poverty and more than 15% of the people are undernourished, thus vulnerable to various health problems. Nutritional supplementation is done through many modes like commercial fortification, medical supplementation, dietary diversification and biofortification.

Indian Council of Agricultural Research has recognized the pressing need for the nutritional biofortification of the staples and initiated many programmes in different crops. It gives me immense pleasure to mention that National Agricultural Research System including ICAR and State Agricultural Universities (SAUs) have made a significant progress in development of many biofortified varieties of cereals, pulses, oilseeds, vegetables and fruits during last 3-4 years which is being published in the form of a booklet entitled, "Biofortified Varieties: Sustainable Way to Alleviate Malnutrition" to make awareness among the stakeholders and consumers. I am sure that this publication will be of immense use in popularizing the biofortified varieties of different crops in the country and will help in reducing the hidden hunger among the masses.

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I congratulate the developers of these varieties and appreciate the Indian Council of Agricultural Research for this initiative.

(RADHA MOHAN SINGH)

Dated 24 October, 2017
New Delhi

त्रिलोचन महापात्र, पीएच.डी.
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सचिव एवं महानिदेशक
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कृषि अनुसंधान और शिक्षा विभाग एवं
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FOREWORD

Sustainable Development Goals laid by the United Nations urge the global communities to ensure food security *vis-à-vis* nutritional security. While, 795 million people are undernourished, malnutrition affects an estimated two billion people globally. South Asia is home to more than 35% of the world's poor and 21.9% of the population of India lives in poverty. India is home to world's highest under-nourished people (194.6 million), where 38.4% of the children (<5 years) are stunted and 35.7% are underweight. Annually, India loses over $12 billion in GDP due to vitamin and/or mineral deficiencies.

It is important that we mainstream food and nutrition through our public distribution system. It is estimated that every $1 invested in proven nutrition programme offers benefits worth $16. To this effect, agriculture R&D in India led by the Indian Council of Agricultural Research (ICAR) has initiated biofortification in crops as a sustainable and cost-effective solution to alleviate malnutrition. So far, ICAR has developed over a dozen of biofortified varieties of crops that could be integrated into the food chain to enable better health of our human and animal populations. The recent 'National Nutrition Strategy' by the NITI Aayog, Govt. of the India, would also provide impetus to utilize these biofortified varieties more effectively towards achieving *'Kuposhan Mukt Bharat'*.

This bulletin entitled, ***"Biofortified Varieties: Sustainable Way to Alleviate Malnutrition"*** on the biofortified varieties, highlights the yield potential along with respective nutritional characteristics foresighting nutritional security in this country. I dedicate this information bulletin to all our fellow citizens.

(T. MOHAPATRA)

Dated 23 October, 2017
New Delhi

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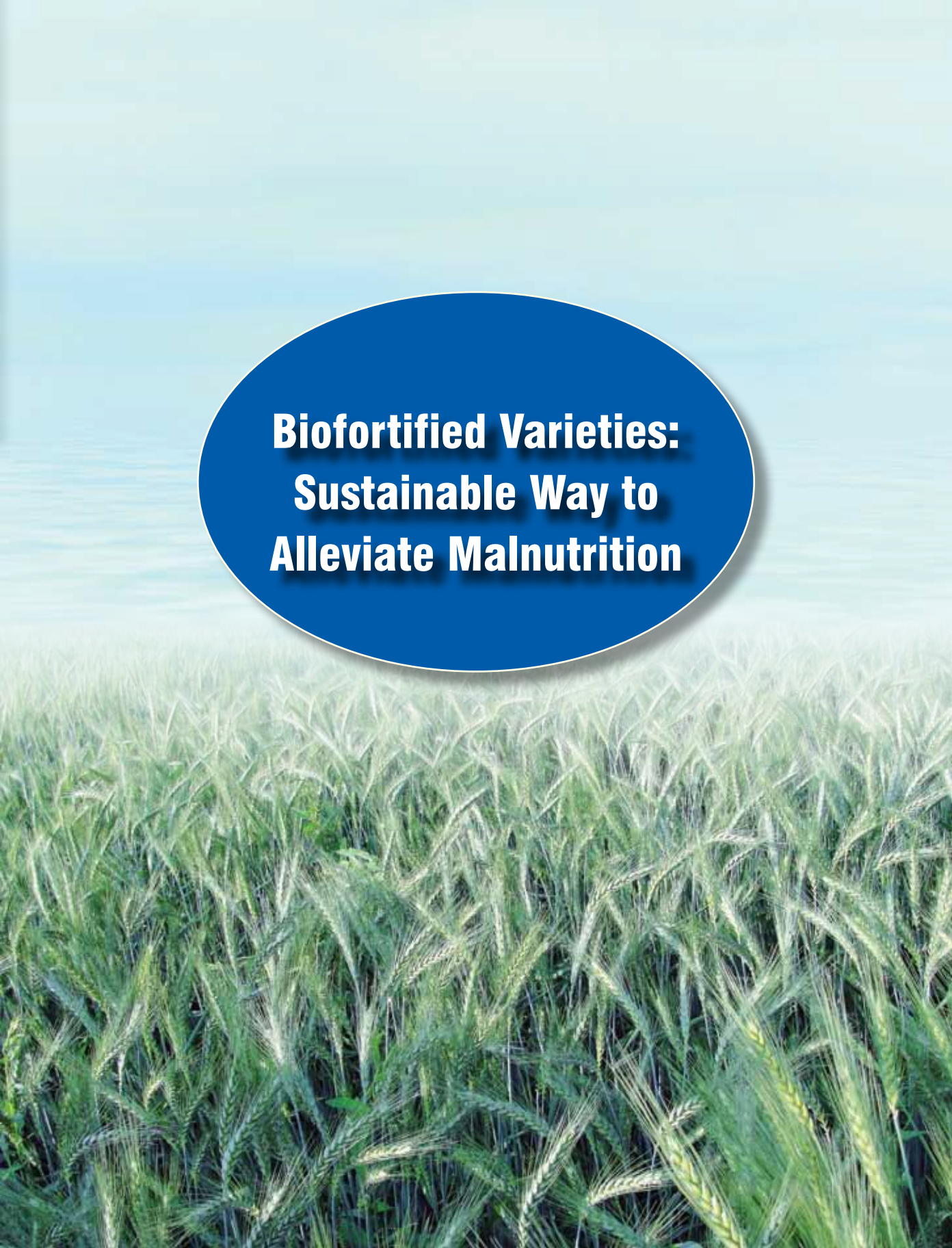

Introduction

Nutritious diet is vital for proper growth and development in humans. It helps preventing diseases, besides maintaining the body metabolism for physical- and mental- well being. Food provides energy, protein, essential fats, vitamins, antioxidants and minerals to meet our daily metabolic requirement. Most of them cannot be synthesized in human body, therefore are to be supplemented through diet. Further, anti-nutritional factors present in edible parts of the food exert adverse affects on human health. Consumption of unbalanced foods affects billions of people worldwide, and leads to poor health and socio-economic conditions. So far, the focus has been on the development of high yielding varieties primarily to feed the ever increasing populations. Indian Council of Agricultural Research (ICAR) has improved the nutritional quality in high yielding varieties of cereals, pulses, oilseeds, vegetables and fruits. Till now more than 5600 varieties of different crops have been released of which no. of biofortified varieties is negligible. These biofortified varieties assume great significance to achieve nutritional security of the country.

Rice: CR Dhan 310

(Pure line variety)

Protein 10.3%

- Contains 10.3% protein in polished grain as compared to 7.0-8.0% in popular varieties
- Grain yield: 45.0 q/ha
- Maturity: 125 days
- Adaptation: Odisha, Madhya Pradesh and Uttar Pradesh
- Developed by ICAR-National Rice Research Institute, Cuttack, Odisha

Year of release: 2016

Rice: DRR Dhan 45

(Pure line variety)

Zinc 22.6 ppm

- High in zinc content (22.6 ppm) in polished grains in comparison to 12.0-16.0 ppm in popular varieties
- Grain yield: 50.0 q/ha
- Maturity: 125-130 days
- Adaptation: Karnataka, Tamil Nadu, Andhra Pradesh and Telangana
- Developed by ICAR-Indian Institute of Rice Research, Hyderabad

Year of release: 2016

Wheat: WB 02

(Pure line variety)

Zinc 42.0 ppm

Iron 40.0 ppm

- Rich in zinc (42.0 ppm) and iron (40.0 ppm) in comparison to 32.0 ppm zinc and 28.0-32.0 ppm iron in popular varieties
- Grain yield: 51.6 q/ha
- Maturity: 142 days
- Suitable for irrigated timely sown conditions
- Adaptation: Punjab, Haryana, Delhi, Rajasthan (excluding Kota and Udaipur division), Western UP (except Jhansi division), Jammu and Kathua district of J & K, Paonta Valley and Una district of HP and Tarai region of Uttarakhand
- Developed by ICAR-Indian Institute of Wheat and Barley Research, Karnal

Year of release: 2017

Wheat: HPBW 01

(Pure line variety)

Iron 40.0 ppm

Zinc 40.6 ppm

- Contains high iron (40.0 ppm) and zinc (40.6 ppm) in comparison to 28.0-32.0 ppm iron and 32.0 ppm zinc in popular varieties
- Grain yield: 51.7 q/ha
- Maturity: 141 days
- Suitable for irrigated timely sown conditions
- Adaptation: Punjab, Haryana, Delhi, Rajasthan (excluding Kota and Udaipur division), Western UP (except Jhansi division), Jammu and Kathua district of J & K, Paonta Valley and Una district of HP and Tarai region of Uttarakhand
- Developed by Punjab Agricultural University, Ludhiana under ICAR-All India Coordinated Research Project on Wheat & Barley

Year of release: 2017

Maize: Pusa Vivek QPM9 Improved

(Hybrid)

Provitamin-A 8.15 ppm

Lysine 2.67%

Tryptophan 0.74%

- Country's first provitamin-A rich maize
- High provitamin-A (8.15 ppm), lysine (2.67%) and tryptophan (0.74%) as compared to 1.0-2.0 ppm provitamin-A, 1.5-2.0% lysine and 0.3-0.4% tryptophan content in popular hybrids
- Grain yield: 55.9 q/ha [Northern Hills Zone (NHZ)] and 59.2 q/ha [Peninsular Zone (PZ)]
- Maturity: 93 days (NHZ) and 83 days (PZ)
- Adaptation: *Kharif* season in J&K, Himachal Pradesh, Uttarakhand (Hill region), North Eastern states, Maharashtra, Karnataka, AP, Telangana and Tamil Nadu
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2017

Maize: Pusa HM4 Improved

(Hybrid)

Tryptophan 0.91%

Lysine 3.62%

- Contains 0.91% tryptophan and 3.62% lysine which is significantly higher than popular hybrids (0.3-0.4% tryptophan and 1.5-2.0% lysine)
- Grain yield: 64.2 q/ha
- Maturity: 87 days
- Adaptation: *Kharif* season in Punjab, Haryana, Delhi, Uttarakhand (Plain), Uttar Pradesh (Western region)]
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2017

Maize: Pusa HM8 Improved

(Hybrid)

Tryptophan 1.06%

Lysine 4.18%

- Rich in tryptophan (1.06%) and lysine (4.18%) as compared to 0.3-0.4% tryptophan and 1.5-2.0% lysine in popular hybrids
- Grain yield: 62.6 q/ha
- Maturity: 95 days
- Adaptation: *Kharif* season in Maharashtra, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2017

Maize: Pusa HM9 Improved

(Hybrid)

Tryptophan 0.68%

Lysine 2.97%

- Contains 0.68% tryptophan and 2.97% lysine compared to 0.3-0.4% tryptophan and 1.5-2.0% lysine in popular hybrids
- Grain yield: 52.0 q/ha
- Maturity: 89 days
- Adaptation: *Kharif* season in Bihar, Jharkhand, Odisha, Uttar Pradesh (Eastern region) and West Bengal
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2017

Pearl millet: HHB 299

(Hybrid)

Iron 73.0 ppm

Zinc 41.0 ppm

- High iron (73.0 ppm) and zinc (41.0 ppm) as compared to 45.0-50.0 ppm iron and 30.0-35.0 ppm zinc in popular varieties/hybrids
- Grain yield: 32.7 q/ha
- Dry fodder yield: 73.0 q/ha
- Maturity: 81 days
- Adaptation: *Kharif* season in Haryana, Rajasthan, Gujarat, Punjab, Delhi, Maharashtra and Tamil Nadu
- Developed by CCS-Haryana Agricultural University, Hisar in collaboration with ICRISAT, Patancheru under ICAR-All India Coordinated Research Project on Pearl millet

Year of release: 2017

Pearl millet: AHB 1200

(Hybrid)

Iron
73.0 ppm

- Rich in iron (73.0 ppm) in comparison to 45.0-50.0 ppm in popular varieties/hybrids
- Grain yield: 32.0 q/ha
- Dry fodder yield: 70.0 q/ha
- Maturity: 78 days
- Adaptation: Kharif season in Haryana, Rajasthan, Gujarat, Punjab, Delhi, Maharashtra and Tamil Nadu
- Developed by Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS) in collaboration with ICRISAT, Patancheru under ICAR-All India Coordinated Research Project on Pearl millet

Year of release: 2017

Lentil: Pusa Ageti Masoor

(Pure line variety)

Iron
65.0 ppm

- Contains 65.0 ppm iron as compared to 55.0 ppm iron in popular varieties
- Grain yield: 13.0 q/ha
- Maturity: 100 days
- Medium seed with orange cotyledon
- Suitable for rainfed condition
- Adaptation: Utter Pradesh, Madhya Pradesh, Chhatisgarh
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2017

Mustard: Pusa Mustard 30

(Pure line variety)

Erucic acid <2.0%

- Contains low erucic acid (<2.0%) in oil as compared to >40% erucic acid in popular varieties
- Oil content: 37.7%
- Seed yield: 18.2 q/ha
- Maturity: 137 days
- Suitable for timely sown irrigated conditions
- Adaptation: Utter Pradesh, Uttrakhand, Madhya Pradesh and Rajasthan
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2013

Mustard: Pusa Double Zero Mustard 31

(Pure line variety)

Erucic acid <2.0%

Glucosinolates <30.0 ppm

- Country's first Canola Quality Indian mustard variety
- Low erucic acid (<2.0%) in oil and glucosinolates (<30.0 ppm) in seed meal as compared to >40.0% erucic acid and >120.0 ppm glucosinolates in popular varieties
- Oil content: 41.0%
- Seed yield: 23.0 q/ha
- Maturity: 142 days
- Suitable for timely sown irrigated conditions
- Adaptation: Rajasthan (North and Western parts), Punjab, Haryana, Delhi, Western UP, Plains of J&K and HP
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2016

Cauliflower: Pusa Beta Kesari 1

(Pure line variety)

β-carotene 8.0-10.0 ppm

- Country's first biofortified cauliflower
- Contains high β-carotene (8.0-10.0 ppm) in comparison to negligible β-carotene content in popular varieties
- Curd yield: 40.0-50.0 t/ha
- Adaptation: Nation Capital Region of Delhi
- Developed by ICAR-Indian Agricultural Research Institute, New Delhi

Year of release: 2015

Sweet Potato: Bhu Sona

(Pure line variety)

β-carotene 14.0 mg/100g

- High β-carotene (14.0 mg/100 g) content as compared to 2.0-3.0 mg/100 g β- carotene in popular varieties
- Tuber yield: 19.8 t/ha
- Dry matter: 27.0-29.0%
- Starch: 20.0%
- Total sugar: 2.0-2.4%
- Adaptation: Odisha
- Developed by ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala

Year of release: 2017

Sweet Potato: Bhu Krishna

(Pure line variety)

Anthocyanin 90.0 mg/100g

- High anthocyanin (90.0 mg/100g) content in comparison to popular varieties which have negligible anthocyanin content
- Tuber yield: 18.0 t/ha
- Dry matter: 24.0-25.5%
- Starch: 19.5%
- Total sugar: 1.9-2.2%
- Salinity stress tolerant
- Adaptation: Odisha
- Developed by ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala

Year of release: 2017

Pomegranate: Solapur Lal

(Hybrid)

Iron 5.6-6.1 mg/100g

Zinc 0.64-0.69 mg/100g

Vitamin C: 19.4-19.8 mg/100g

- High iron (5.6-6.1 mg/100g), zinc (0.64-0.69 mg/100g) and vitamin C (19.4 -19.8 mg/100 g) in fresh arils in comparison to 2.7-3.2 mg/ 100g, 0.50-0.54 mg/100g and 14.2-14.6 mg/100g, respectively in popular variety Ganesh
- Fruit yield: 23.0-27.0 t/ha
- Adaptation: Semi-arid regions of the country
- Developed by ICAR-National Research Centre on Pomegranate, Pune

Year of release: 2017







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