Journal of Nutrition & Intermediary Metabolism 18 (2019) 100100

Contents lists available at ScienceDirect

Journal of Nutrition & Intermediary Metabolism

journal homepage: www.elsevier.com/locate/jnim

Proceedings of the workshop 'Biofortified food - Working together to get more nutritious food to the table in India'

Tora Mitra-Ganguli[a,*], Katrina Boyd[b], Benjamin Uchitelle-Pierce[b], Jenny Walton[b,**]

[a] Indian Institute of Technology Tirupati, India
[b] HarvestPlus, International Food Policy Research Institute, USA

HIGHLIGHTS

- There is big demand for naturally nutritious grains in India – from consumers, food manufacturers and retailers.
- The market segment for naturally nutritious foods is in double digit growth in India.
- HarvestPlus presented the existing barriers to scale and proposed ideas to fix them – there was broad agreement on the issues we face – the audience brought more context from India to the barriers and solutions and more details which allow for stronger future proposals.

ARTICLE INFO

Keywords:
Biofortification
HarvestPlus
Scale
Value chain
Workshop
Barrier

ABSTRACT

HarvestPlus is the global leader in biofortification and has been leading biofortification efforts in India for nearly a decade. A workshop hosted by HarvestPlus was held in April 2019 in New Delhi to discuss ways to increase the scale, reach and impact of naturally nutritious (biofortified) foods in India by working in partnership with the food industry. This paper summarizes the output of that 2-day workshop. HarvestPlus has conducted research into the barriers for scale-up and co-created solutions to overcoming those barriers through partnership with the food industry. During this workshop, it emerged that there is significant demand from the food industry who see value in biofortification to both their business and the health of their customers and the country. Small working groups explored specific opportunities around supply chains, food products and composition, and consumers & markets. Several common themes emerged from the deliberations. All three groups identified lack of awareness as a major barrier to scale. More data on the health and nutrition impacts, as well as consumer and market research, is critically needed to build the food industry's understanding of biofortified foods. Ensuring supply chain integrity, meeting manufacturing product standards, and developing strategic messaging for consumers were also mentioned repeatedly. Ending hidden hunger and managing a profitable food business can be done simultaneously and sustainably. By addressing the barriers to embedding biofortification into the food system, HarvestPlus aims to increase the access that families and communities have to nutritious seeds and foods. This paper; is a summary of the activities required to take the nutritional requirements of foods, to; crop development all the way to food on consumers plates. Topics include current nutrition impact evidence, policy support, farmer issues, the requirements of the food industry and food product marketing and communication.

1. Introduction to biofortification as a strategy to tackle malnutrition

Biofortification is the process of breeding food crops to create crops that are richer in micronutrients, such as vitamin A, zinc, and iron. These crops "biofortify" themselves by loading higher levels of minerals and vitamins in their seeds and roots while they are growing. When consumed, they can provide essential micronutrients that can improve nutrition and public health [1]. There are several definitions of biofortification used for different purposes. The U.S. Department of Agriculture (USDA) National Agricultural Library (NAL) Agricultural Thesaurus (NALT) [2] defines biofortification as follows: An increase in the nutritional value of plant foods obtained through conventional crop breeding methods or through crop genetic engineering techniques. This

* Corresponding author. Indian Institute of Technology Tirupati, Tirupati-Renigunta Road, AP, 517506, India.
** Corresponding author. Demand Creation and Business Development HarvestPlus, International Food Policy Research Institute, 1201 Eye Street NW, Washington, DC, 20005, USA.
E-mail addresses: tora.ganguli@iittp.ac.in (T. Mitra-Ganguli), j.walton@cgiar.org (J. Walton).

https://doi.org/10.1016/j.jnim.2019.100100
Received 24 July 2019; Received in revised form 18 September 2019; Accepted 18 September 2019
Available online 27 September 2019

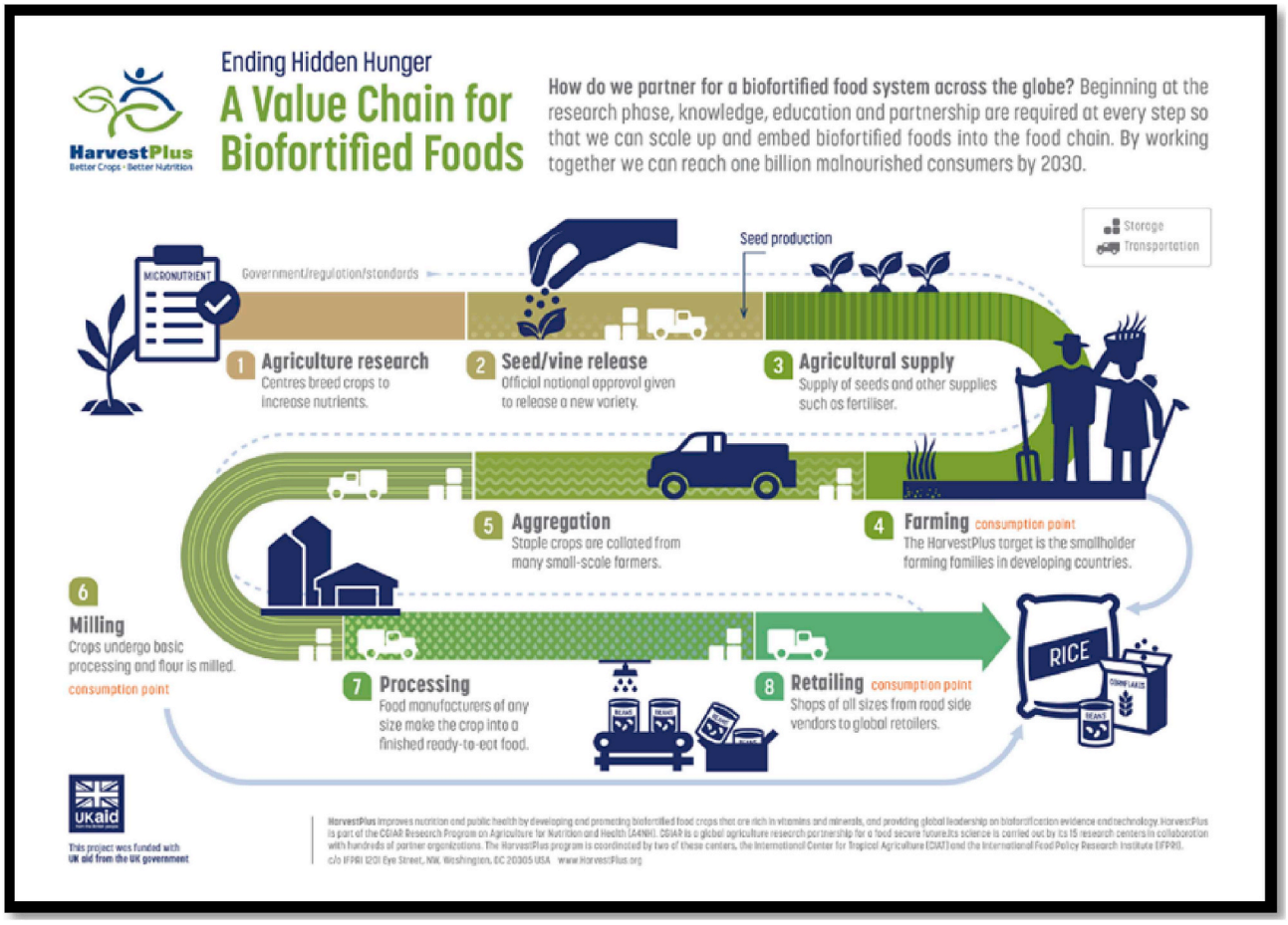

Fig. 1. Value chain for biofortified foods.

contrasts with postharvest fortification in which nutrients are added during processing. WHO defines biofortification as follows: Biofortification is the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, or modern biotechnology [3]. Biofortification differs from conventional fortification in that biofortification aims to increase nutrient levels in crops during plant growth rather than through manual means during processing of the crops. Biofortification may therefore present a way to reach populations where supplementation and conventional fortification activities may be difficult to implement and/or limited (see Fig. 1 and 3)

Harvest Plus is a not-for-profit organization that works with its partners to tackle hidden hunger and malnutrition. It leads the global effort to develop biofortified staple crops, explore their acceptability, efficacy and effectiveness, and scale up their availability to rural and urban populations who may not have access to diverse diet, fortified foods or supplements. Scaling the reach and impact of biofortified food through foods systems is a key strategy for HarvestPlus.

Following almost ten years of product development and delivery efforts from the HarvestPlus India program, close to half a million Indian farming households are estimated to be growing, consuming, and benefiting from zinc-biofortified wheat and iron-biofortified pearl millet by the end of 2018. In 2018 alone, about 300,000 farming households have been recorded as having procured seeds of these biofortified crops. There are currently nine varieties of iron pearl millet, five of zinc wheat, and one of both iron-zinc sorghum and zinc rice available. Now that crops have been released, attention is turning to exploring opportunities to create a more nutritious food system.

India loses over US$12 billion in GDP annually to vitamin and mineral deficiencies [4]. Biofortification has the potential to become a critical element in the country's quest for Kuposhan Mukt Bharat (Malnutrition Free India) by 2022 [5]; last year the Indian.

Council for Agricultural Research set minimum levels of iron and zinc for pearl millet varieties—signaling nutrition as a priority for breeders.

Biofortified crops improve micronutrient intake and subsequently improve nutrition status. The African Journal of Food Agriculture, Nutrition and Development published a special issue devoted to biofortification in 2017 [6]. This remains the current comprehensive review of biofortification which covers the topic from overview of the landscape and approach for biofortification in Africa, nutrition and food science, crop development, delivery, measuring impact and public policy. The evidence provided concludes that the nutrients provided by biofortification can be bioavailable and make important changes to public health outcomes.

There are many published intervention studies evaluating the impact of biofortification on public health. Biofortified crops for tackling micronutrient deficiencies were most recently reviewed by the British Nutrition Foundation (BNF) and published in the Nutrition Bulletin [7]. Whilst most of the evidence is in developing countries, biofortification may have the potential to impact public health in developed countries, where further modelling and research are required.

In India in particular, iron pearl millet was demonstrated to be an efficacious approach to improve iron status in adolescent children through a six-month study conducted in rural Maharashtra, India. After only four months, iron deficiency was significantly reduced, and serum ferritin and total body iron were significantly improved in secondary schoolchildren who consumed iron pearl millet flat bread twice daily [8]. When economically-disadvantaged 12–16 year olds in Maharashtra, India, consumed biofortified pearl millet twice daily as *bhakri* (a

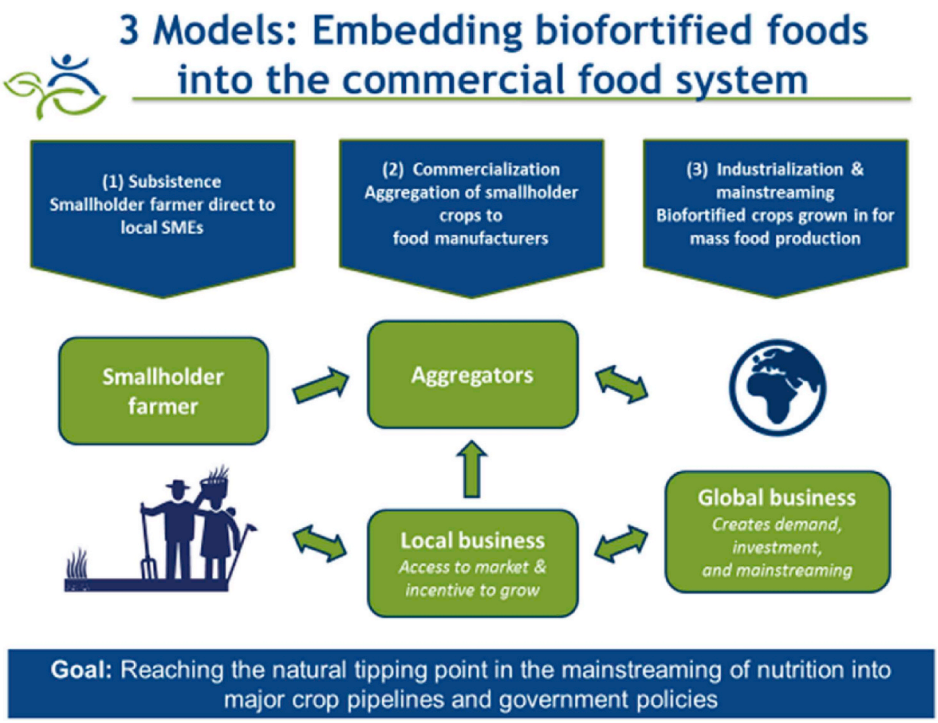

Fig. 2. Embedding biofortified foods into the commercial food system.

local flatbread) or *shev* (a savory snack) for six months, researchers found the students had significantly improved cognitive skills related to perception, attention, and memory [9]. Recently published results from a similar trial indicate that iron biofortified pearl millet consumption also improved cognitive performance [17]. A consumer acceptance study of bhakri made with iron pearl millet conducted in rural Maharashtra, India, revealed that even in the absence of information about the nutritional benefits, consumers liked the sensory attributes of iron pearl millet grain and the bhakri made from it as much as, if not more than, conventional pearl millet grain and bhakri [10]. When nutrition information was provided, consumer acceptance and willingness to pay was even greater. The Indian Council of Agricultural Research (ICAR) has established minimum levels of iron and zinc to be bred into national varieties of pearl millet, including it in the Public Distribution System's mid-day meal scheme for pregnant and lactating women and the Integrated Child Development Services' school feeding program [11,12].

The evidence for zinc wheat is also strong for the public health in India. A large efficacy study including over 3000 mother-child pairs demonstrated that when preschool children aged 4–6 years old in New Delhi, India, consumed foods prepared with wheat agronomically biofortified with zinc for six months, morbidity was significantly reduced: children spent 17% fewer days sick with pneumonia and 40% less days vomiting than children who consumed the same foods made of conventional wheat. Mothers (non-pregnant, non-lactating) who consumed biofortified zinc wheat foods spent a statistically significant 9% fewer days with fever than mothers in the control group [13]. Previous studies in Switzerland and Mexico have shown that absorption of zinc from biofortified zinc wheat is significantly greater than from non-biofortified wheat [14].

The evidence for zinc rice has primarily been shown in Bangladesh. A zinc absorption trial is in progress in Bangladesh, where an efficacy study is also underway to determine the impact of biofortified zinc rice on the nutrition of young children aged 12–36 months. A previous study compared the absorption of zinc from an intrinsically labeled biofortified rice variety to commercially fortified rice in 16 healthy adults. The findings indicated that rice biofortification is as good a source of bioavailable zinc as postharvest zinc fortification [15]. Finally, an absorption study among women in Mexico showed that total absorbed zinc was significantly greater from biofortified wheat than

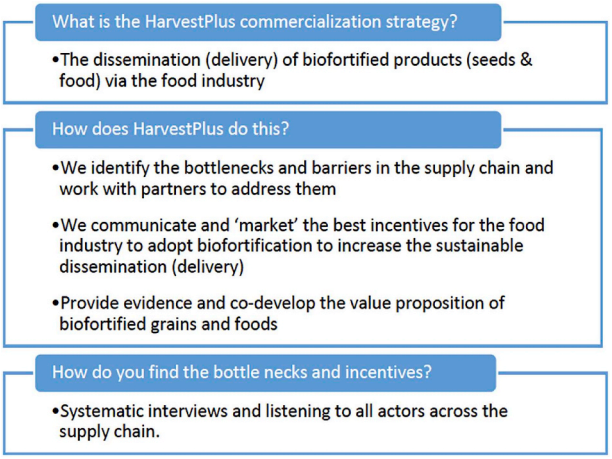

Fig. 3. Strategy for HarvestPlus.

Claim type	Example	How
Nutrition content claims	Source of iron Source of zinc	Use Recommended Daily Amounts for labelling purposes
Nutrition health claims	Iron helps normal brain development of children. Zinc helps to keep your skin healthy.	Use 'text book' or widely accepted functions and don't embellish. (Talk to the NIN)
Nutrition comparison claims	30% more iron than standards pearl millet	30% is a significant difference. Ensure you detail the comparison
Natural source of	Natural source of Iron. Natural source of zinc	Only when naturally occurring, not artificially added

Fig. 4. Nutrition claims on food packaging in India.

from non-biofortified wheat [16].

2. Workshop aim

The aim of the workshop was to bring naturally nutritious millet, rice and wheat into the food system for Indian consumers by identifying sustainable routes to market. Over the two days, the group engaged in collaborative exploration to identify opportunities and overcome barriers to bring biofortified foods to Indian consumers by:

- Partnering with public and private sectors in India to catalyze the dissemination of biofortified foods into local and global food supply.
- Increasing the number of farmers in India growing and consuming zinc biofortified rice, zinc biofortified wheat and iron biofortified pearl millet by creating a market for these foods.

The objectives for the workshop were;

- Demonstrate how biofortified foods can add value to the business
- Communicate market insights and new data about consumers, food product development, food labeling and regulations
- Explore existing barriers to scale and propose innovative solutions
- Listen and document insights about challenges and solutions
- Collaboratively build project proposals to tackle barriers to scale
- Increase awareness of each supply chain actors' needs and role
- Build relationships: network to link actors along the supply chain

3. Building a landscape of the food system in India

Binu Cherian, the India Country Manager, highlighted the mission and objectives of HarvestPlus. The audience comprised of delegates from food producers, farmers, industry leaders, feed/seed sector, policy, academia, research scientists and implementing agencies. He thanked the project donors, including: The Bill & Melinda Gates Foundation, U.K. Department for International Development (DFID), Feed the Future, European Union, MacArthur Foundation and the Indian Council of Agricultural Research (ICAR). ICAR in particular have closely worked with HarvestPlus to help demonstrate initial proof of concept in product development and nutrition research, which has given confidence to scale up the concept. Commercialization is the key to scaling biofortification, reaching greater numbers of especially vulnerable, low income people, and putting nutritious food on the table. It is impossible to achieve this without mobilizing the substantial amount of commercial investment, innovation and implementation capacities of the private sector. Next, Dr. P.K. Joshi, Director of Asia at the International Food Policy Research Institute (IFPRI) briefly gave an overview of the IFPRI and HarvestPlus relationship. He brought up few issues for discussion during the workshop:

1) The concept of biofortification vs GMO food need to be addressed with organizations and policy makers
2) Product differentiation could be led by industries interested in biofortified commodities
3) Developing the value chain (the process or activities by which a company adds value to an article, including production, marketing, and the provision of after-sales service) from farming community to consumers
4) Value addition strategies targeting consumers at different socio-economic levels
5) Behavior change communication strategies

A brief welcome message was conveyed from Dr. MS Swaminathan, the father of the Green Revolution in India and first winner of the World Food Prize. He stressed the development of guidelines to make progress with this workshop. Next in her opening remarks, Dr. Srivalli Krishnan, Senior Program Officer- Global Development for Agriculture at the Bill and Melinda Gates Foundation, expressed significant support for biofortification. A multisectoral approach is needed to effectively target the overall malnutrition problem in India. She compared the approach taken by the Government of India through the “POSHAN Abhiyaan” to a “surgical strike”. Consumption of staples is a dietary pattern that will continue in this population and hence an intervention at that level is important and long-term. She complimented the approach taken by HarvestPlus which is an adaptive movement of the product from research to farmer and eventually to the consumer. It is critical to understand how quickly the product reaches the consumer from the farmer. Two things are required to drive scale-up:

1) push from research and policy side in the government and private sector
2) pull/demand from the consumer to create a market for the product

To conclude, she reminded the audience that there is a need to provide both value and access to biofortified products across all economic sections of the society by creating both niche products for early adopters as well as affordable small sized packages for end consumers in the rural market. The next speaker Dr. Basanta Kar, Country Director at Project Concern International, highlighted some key policy measures to support biofortification-

1) need for a biofortification policy aligned with United Nations Sustainable Development Goals
2) need for institutional arrangements such as National BioSafety Authority in Kenya to set standards, regulate research and commercial activities to ensure safety of human health, animal health and protection of the environment.
3) need for convergence of different ministries and departments and specifically robust convergence systems to be built at district levels and below to promote biofortified crops.
4) Linking with social safety net programs such as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and promotion of cultivation of biofortified crops in government lands
5) generate research-based evidence in India on outcomes of crop modification, diet diversification and food fortification,
6) Need for social behavior change communication and awareness to the government's mandate

7) Availability of diversified and fortified diets in food safety programs such as Integrated Child Development Services, mid-day meal and Public Distribution System (PDS).

8) Premix/fortificant subsidy (by lowering the GST rate) and working capital on production of bio-fortified crops.

4. Why does HarvestPlus invest in this work? The strategy and role of HarvestPlus

The next speaker, Ms Jenny Walton, Business Development and Demand Creation at HarvestPlus, set the scene for the day. She emphasized to the audience that the workshop was particularly relevant in India, as it is one of the most important markets and the first one where HarvestPlus is scaling up biofortification initiatives. India is one of the world leaders in agriculture, with massive potential for economic growth, a booming food industry, and on track to become the third largest economy by 2025. But several challenges still exist, as outlined in the World Bank report cited earlier. The global objective of HarvestPlus is to reach 1 billion people by 2030 through partnerships. As illustrated in Fig. 2, the future of HarvestPlus will be in the catalytic dissemination of biofortified crops via the food industry.

5. Building a common understanding

Giving an overview of the available crop varieties, Dr. Parminder Virk, Head of Crop Development at HarvestPlus, explained that currently there are 9 varieties of iron pearl millets providing 60–66 mg/100 g iron, 5 varieties of zinc wheat providing extra 6–8 mg/100 g zinc over and above baseline values and 1 variety of zinc rice providing 2.3 mg/100 g, i.e., 30% above baseline levels available in India. The audience raised the following questions.

1) Considering that zinc is present in the outer shell of the grain and mostly refined wheat is consumed, how much of the zinc in the wheat is really available in flour that is consumed and used by the industry in different processed food products? Dr. Virk replied that while zinc concentration drops during the process of refining, the phytate content also drops thereby leading to an increase in overall zinc bioavailability.
2) Will use of the biofortified crops automatically lead to claims such as "biofortified" as per FSSAI? Dr. Virk responded by saying consumers do not yet understand the term and it would be advisable to use existing labeling regulations for 'source of' or 'high in' claims.

Mr. Binu Cherian, Country Manager at HarvestPlus India mentioned a project in Bihar sponsored by the Gates Foundation where zinc fortified wheat, zinc fortified rice and iron fortified pearl millets were introduced to the population. The overarching project goal is to create sustainable production and consumption systems, by developing enabling policies and creating value linkages to scale up biofortified crops in Bihar. . He discussed the data from two, recently published nutritional studies in India which show that consumption of iron biofortified pearl millet improves cognitive function in adolescents [9] while consumption of zinc wheat improves micronutrient status among children [13]. Overall, efficacy studies have shown improved physical work capacity (iron), reduced pneumonia and vomiting (zinc) and better sight adaptation to darkness (provitamin A) [6].

5.1. Barriers and solutions in supply

Mr. Benjamin Uchitelle-Pierce, Special Assistant to the CEO for HarvestPlus, introduced the findings of extensive stakeholder research conducted by HarvestPlus, which included interviewing approximately 100 businesses and 250 individuals over a one-year period. The interviews uncovered three main barriers for scaling up of biofortification, which are summarized in Table 1:

5.2. Smallholder farmer experience

To increase the relevance of the consumer research, farmer groups were invited to the workshop to present their perspective on biofortification. The farmer groups cultivating biofortified crops were represented by Mr. Harbansh Singh and Mr. Ram Krishna Pathak. Singh recalled his experience working with agricultural scientists at Banaras Hindu University (BHU) in Varanasi, India and acknowledged the contribution of the Gates Foundation. He stated, "As farmers we are proud to be actively involved with the HarvestPlus program since its inception at BHU, in testing, evaluation of new zinc wheat varieties, and seed production." He shared his plans to establish a flour mill, which would process wheat from an aggregate of 90 farmers growing biofortified wheat on 90 ha of land. Mr. Ram Krishna Pathak has worked with high yielding wheat varieties with BHU scientists since 2001: "As farmers it is our dream to get the zinc wheat flour to the consumers, that will help not only farming communities but also achieve long term sustainability." The farmers mentioned that they regularly consumed the biofortified wheat and also distributed biofortified wheat to the field workers for their families' home consumption. They commented that the breads are softer and taste much better than breads made with conventional, non-biofortified wheat varieties. It was evident that while smallholder farmers are willing to grow and eat the biofortified varieties, establishing a clear route to market, ensuring demand, and developing technical solutions for supply chain development are still key challenges to be overcome.

6. Providing technical solutions to link farmers to inputs and markets

Drawing on his expertise in providing agriculture-related intelligence and access to products in rural Odisha, Mr. Suvankar Mishra, CEO of Blooom Foods, discussed technology solutions for farmers. Mobile app platforms, for example, can provide the latest information generated by research as well as market trends for crop varieties, cultivation practice, and quality parameters to be followed. He spoke about the democratization of global agriculture with a platform that encompasses the agricultural supply chain, connecting 500 million smallholder farms to knowledge, finance, and markets.

6.1. Labelling, regulations, and marketing to consumers

The role of HarvestPlus lies in uncovering the bottlenecks and finding solutions, initiating standards and regulations to enable free trade, linking users of biofortified grains to information on regulations and standards, and providing information to facilitate easier sale and marketing of biofortified foods. Ms Walton presented opportunities for food product labelling in India, based on research conducted by Leatherhead Food Research agency, summarized in Fig. 4. Food labelling in India is covered by the food safety and standards (packaging and labelling) regulations, 2011 [18–20]. The Food Safety and Standard

Table 1
Barriers to scale & solutions (Supply).

Quantifiable demand exists, but no supply
Need a clear route to market & supply chain development in underdeveloped markets
• Facilitate & build food supply chains; HarvestPlus is the honest broker of the biofortification supply chain • Ensure supply meets demand • Communicate demand to seed sellers, farmers, and aggregators • Find technical solutions in partnership with Agri Tech companies
Lack of traceability and identity preservation throughout the supply chain
• Implement traceability schemes with technology such as Distributed Ledger Technology, known as Blockchain
Lack of standards & regulatory frameworks
• Facilitate development of local and global standards and definitions

Table 2
Barriers to scale & solutions (Demand).

Value proposition for businesses and consumers is not clear	•Partner with expert communications agencies & food businesses to create the value proposition for each crop • Understand the market & where biofortification fits – the market opportunity • Work with consumer research agencies to create product concepts and nutrition and health claims •Create a pipeline of food product development to demonstrate food product renovation and innovation
Lack of traceability and identity preservation throughout the supply chain	• Systematic communications through designated communication channels to promote and raise awareness of the expertise of HarvestPlus

Authority of India (FSSAI) regulations have not established specific requirements for either "natural source of" claims, nutrient content claims or comparative claims. The FSSAI regulations simply provide the definition of nutrition claim: "Nutrition claim" means any representation which states, suggests or implies that a food has particular nutritional properties which are not limited to the energy value but include protein, fat carbohydrates, vitamins and minerals. In the absence of specific requirements, "natural source of" claims, nutrient content claims or comparative claims would be permitted in India, provided it is truthful and non-misleading. When communicating with consumers about biofortification, general, non-misleading and truthful principals apply. She concluded that current labelling regulations permit for clear, transparent and motivating ways to convey the naturally nutritious benefits of biofortified foods to consumers.

7. Barriers and solutions to create demand

Ms. Katrina Boyd, Program Associate at HarvestPlus, presented the demand-side challenges and opportunities for scaling biofortified foods. While demand already exists and the new crop attributes are critically needed, the challenge is that these attributes are not "top of mind" for targeted consumers. She emphasized that it will require a unique and creative mix of marketing, sales, and developing public relations, as well as powerful stakeholder relationships, to overcome the momentum of current consumer preferences. Referencing the earlier stakeholder analysis, she introduced two main barriers and proposed several solutions, as summarized in Table 2, to generate increased demand for biofortified foods.

To generate demand for biofortified foods, clear value propositions must be established for each crop. One solution put forth by HarvestPlus is to create a pipeline of food product development to demonstrate food product renovation and innovation. Expert speakers offered their perspectives, summarized in the figure below, on product innovation, renovation, and recommendations for packaged food labelling & regulations (see Fig. 5).

7.1. Working together to build opportunities

Small working groups explored specific opportunities around supply chains, food products and composition, and consumers & markets. Groups were asked to think about the barriers, gaps, solutions, project plans, partners, and next steps for scaling biofortified foods in India via the food industry. Figs. 6–8 below summarize the main discussion points for each opportunity.

As each group presented their discussions and main conclusions, several common themes emerged. All three groups identified lack of awareness as a major barrier to scale. More data on the health and nutrition impacts, as well as consumer and market research, is critically needed to build the food industry's understanding of biofortified foods. Ensuring supply chain integrity, meeting manufacturing product standards, and developing strategic messaging for consumers were also mentioned repeatedly. Though each group developed next steps specific

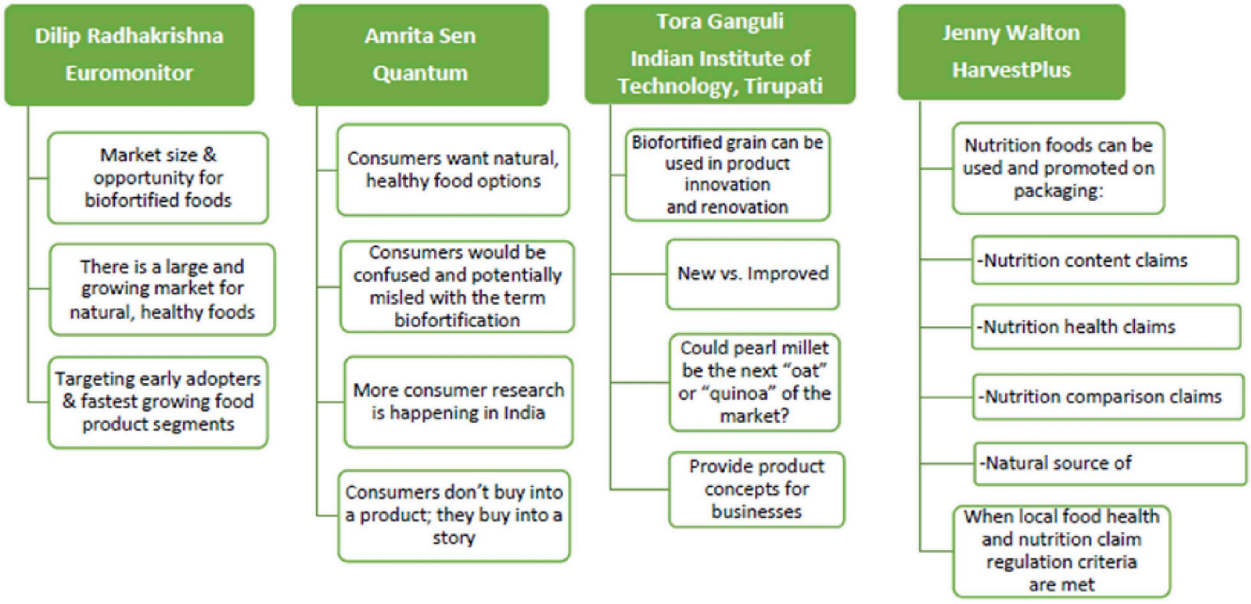

Fig. 5. Generating demand for biofortified crops.

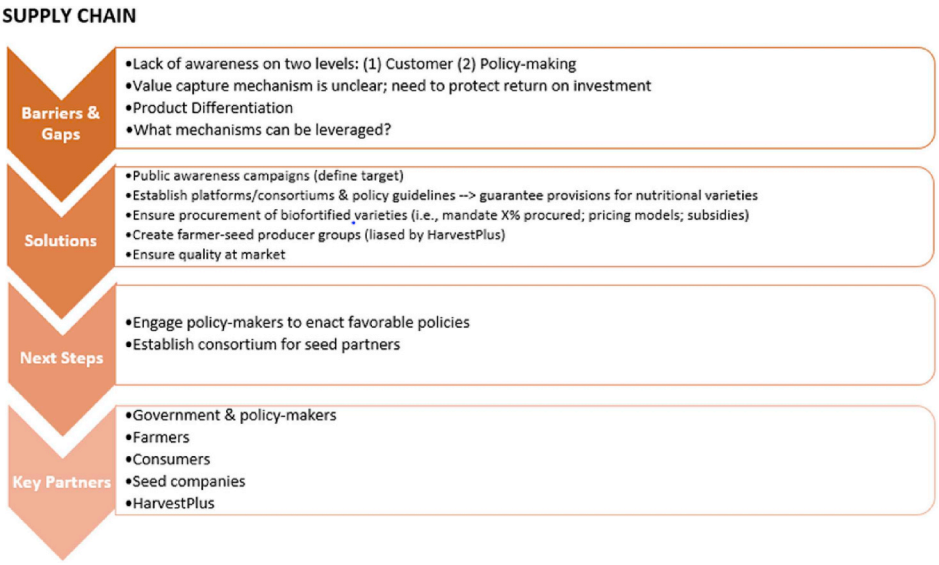

Fig. 6. Supply Chain perspective.

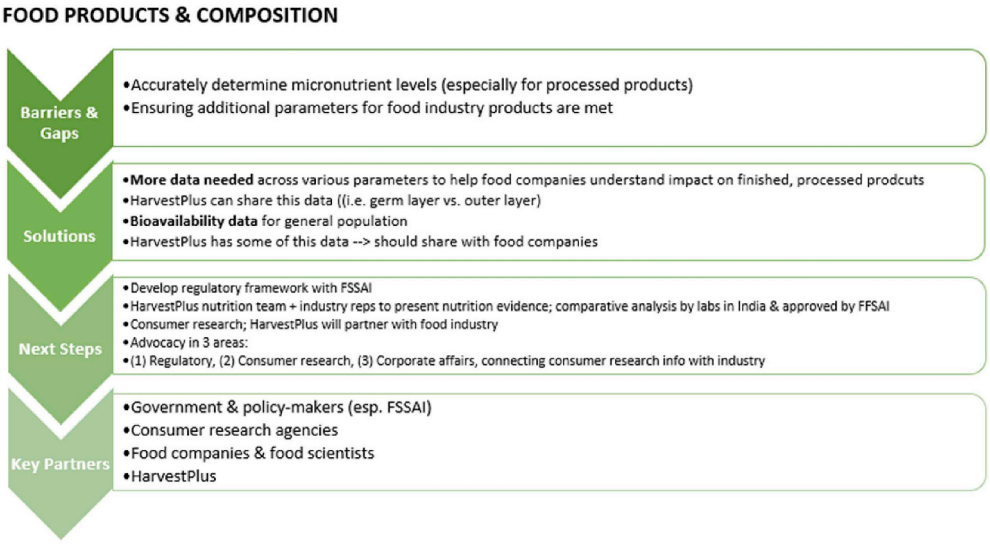

Fig. 7. Food Products & Composition perspective.

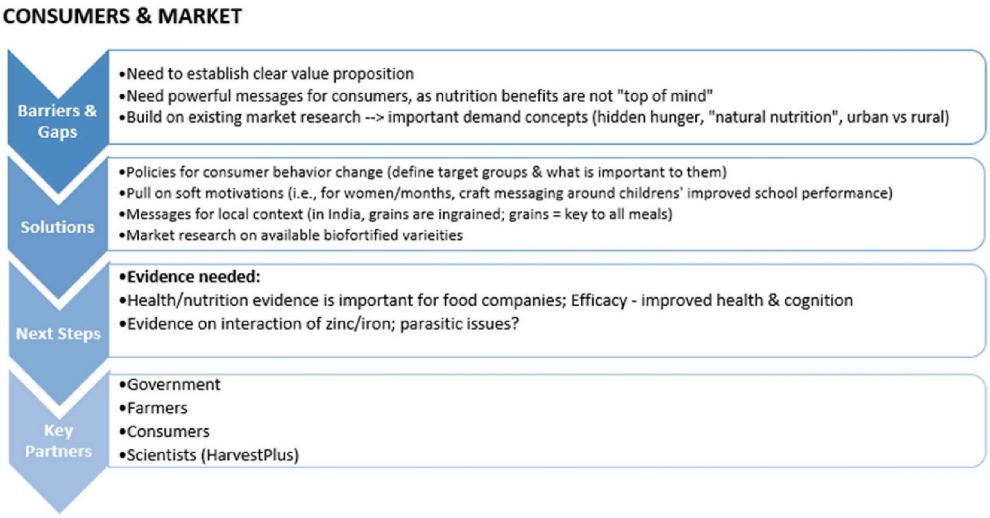

Fig. 8. Consumers & Markets perspective.

to their opportunity and generated unique project plans, there was a good amount of overlap in the key partners. In all cases, the Indian government, policy-makers, farmers, and food industry will play an important role in driving commercialization. These conclusions reinforced the barriers and solutions initially presented by HarvestPlus. In addition, the participants' perspectives added valuable local context for India and greater details which will strengthen future proposals.

8. Case studies – working with biofortified foods

On the second day of the workshop, individuals and companies from across the value chain shared experiences working with biofortified crops. Milind Kulkarni, Senior Scientist (Cereal Crops) of Nirmal Seeds, addressed the challenges and innovative solutions in the seed industry, while acknowledging Nirmal Seeds' pioneering work with biofortified seed varieties of iron pearl millet. DC Singla from Arti Roller Flour Industries emphasized the critical role of partnership in catalyzing business growth. This was further reinforced by Yery Mendoza, Senior Project Manager at Nestle Research NHW who illustrated the successful partnership between HarvestPlus and Nestle in Nigeria. He stressed that global and big business are often early adopters. CS Jadhav, Founder of Inner Being, offered an alternative perspective. He testified to the 40% year-over-year business growth that his small, start-up enterprise has witnessed with pearl millet products.

Isabel Spaven-Donn, Health Sector Lead of Edelman Communications, discussed strategies for driving consumer awareness, emphasizing the need to build trust and educate consumers, establishing credibility, and the importance of choosing the right platforms and partnerships for successful products. Spaven-Donn's messages were echoed by Turab Lakdawala, Managing Director of Tempest Advertising Pvt. Lt who offered further insight on targeted communications for innovative products and rural communities. He argued strongly that communicating the commercial and nutritional benefits of biofortified crops will be essential for farmer adoption.

9. Reflections

Participants were asked to reflect upon the most compelling information that had been presented over the two-day workshop. There was broad agreement that challenges exist at each step of the supply chain, from agricultural research to retailing. The group restated the importance of questions related to ensuring competitive yield, creating linkages between farmers and processors, increasing costs for millers, and shelf-life challenges, among many others. Convening supply chain actors and businesses through workshops like this one is a critical step towards building biofortified supply chains in India. In addition, developing clear value propositions and communicating the benefits of biofortification to businesses and consumers will contribute to the scaling of biofortified foods. From these reflections and group discussions, a set of next steps and specific outputs were put forth to inform the strategic direction of embedding biofortified foods into the global food system.

10. Next steps – outputs and strategic direction

Below, Table 3 summarizes the next steps and specific outputs of the workshop, including immediate actions, medium-term activities, and the longer-term vision as agreed upon by the workshop team. In the near term, the workshop team will be responsible for compiling full written proceedings of the workshop, exploring opportunities for partnerships with local Indian food businesses, evaluating market research, seeking technical solutions, and developing standards. In the medium term, developing strategic communications, partnerships, and continuing engagement with key stakeholders and donors will be crucial. At that time, the progress achieved by various workgroups and completed tasks will emerge as clear workstreams. In the long-term, these workstreams will contribute to the ultimate goal of scaling the availability and accessibility of biofortified foods both in India and around the globe.

Table 3
Next steps and vision for the program.

Short term actions –
- Submit full written proceedings of the workshop to an international journal for peer review and publication.
- Compile notes and actions of the meeting into project proposals.
- Initiate confidential conversations and NDAs with individual food businesses interested in procuring or developing products using biofortified grains.
- Start progress on a consumer research project for product concept testing.
- Evaluate market research and next proposals for research.
- Coordinate standards development with international standards organization.
- Explore technical solutions linking farmers to biofortified inputs and access to markets.

Mid-term deliverables –
- Develop strategic communications plan to highlight work to key stakeholders.
- Pursue food partnerships with several millers and food processors.
- Host webinar to reconvene the workshop cohort to update on short-term activities.
- Continue consultations with donors and partners.
- Publish the academic, workshop proceedings paper in conjunction with the communications plan.
- Commence supply chain integrity project.
- Develop clear project proposals for investor support; develop a resource mobilization plan for each workstream.
- Progression of wider strategic plan to embed biofortification into the food system of India
- Build advocacy and communications strategies following a review of current situation in India.

Longer term vision –
- Activating of each workstream.
- Replicate activities in other developed markets (i.e. Nigeria, Latin America).
- Develop international food standards for biofortified grain.
- Establish process to preserve the identity of biofortified products throughout the value chain.
- Develop an independent 'signpost' to signal to consumers which food products are made from biofortified grains.
- Food businesses regularly procure biofortified grains.
- Biofortified food products available on the market

11. Conclusions

Following the success of similar food industry workshops in London and Nigeria [21], attendees convened with the aim of bringing biofortified food products to more Indian consumers by identifying sustainable routes to market. The findings at this meeting were not different in their conclusions to the other events. This suggests that same barriers to scale and commercialization exist in multiple markets. The goal was to overcome barriers and identify opportunities such as ensuring supply chain integrity and meeting manufacturing standards.

Key takeaways from the meeting:

1) There is large demand for naturally nutritious grains in India – from consumers, food manufacturers and retailers.
2) The market segment for naturally nutritious foods is in double digit growth in India
3) HarvestPlus presented the existing barriers to scale and proposed ideas to fix them. While there was broad agreement on the issues faced, the audience added valuable context from India and provided details which will contribute to strong proposals for food partnerships in the future.

Key activities that will drive commercialization in India:

1) Convening supply chain actors and businesses to build supply chains.
2) Reduce the barriers, such as supply chain integrity and lack of published standards for biofortified grains.
3) Build consumer value propositions – show the demand from

customers and consumers, demonstrate how to communicate the value of biofortification to customers and consumers.
4) Demonstrate and communicate the demand from industry to all supply chain actors.

HarvestPlus will seek to communicate the barriers and solutions so that global solutions can be found applicable for other countries and crops. For example, standards for biofortified crops and commodities at grain level could be built at a global level and implemented locally. HarvestPlus, the pioneer of biofortification, continues to share knowledge and facilitate connections among the growing network of partners to drive and connect supply and demand.

Author statement

Tora Mitra-Ganguli was involved in methodology, writing the original draft, review and editing Katrina Boyd was involved in methodology; project administration, review and editing.

Benjamin Uchitelle-Pierce was involved in review and editing, project administration, supervision Jenny Walton was involved in conceptualization, funding acquisition, methodology, project administration; resources, supervision, Writing - review & editing.

Acknowledgements

HarvestPlus is grateful to the participants for their hard work and enthusiasm during the biofortification workshop.

HarvestPlus improves nutrition and public health by developing and promoting biofortified food crops that are rich in vitamins and minerals and providing global leadership on biofortification evidence and technology. HarvestPlus is part of the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH). CGIAR is a global agriculture research partnership for a food secure future. Its science is carried out by its 15 research centers in collaboration with hundreds of partner organizations. HarvestPlus is based at the International Food Policy Research Institute (IFPRI) and collaborates with multiple CGIAR centers and partner organizations.

HarvestPlus' principal donors are the UK Government; the Bill & Melinda Gates Foundation; the U.S. Government's Feed the Future initiative; the European Commission; the Government of Canada and donors to A4NH. HarvestPlus is also supported by the John D. and Catherine T. MacArthur Foundation.

https://www.harvestplus.org/

References

[1] HarvestPlus. Our History, HarvestPlus, Washington, DC, 2018 Published online at www.harvestplus.org/about/our- history.
[2] U.S. Department of Agriculture and U.S. Department of Health and Human Services, Scientific Report of the 2015 Dietary Guidelines Advisory Committee, U.S. Government Printing Office, Washington, DC, 2015 Published online at http://health.gov/dietaryguidelines/2015-scientific- report/pdfs/scientific-report-of-the-2015-dietary-guidelines-advisory- committee.pdf.
[3] World Health Organization, Biofortification of staple crops, WHO, Geneva, Switzerland, 2019 Published online at www.who.int/elena/titles/biofortification.
[4] https://www.worldbank.org/en/news/press-release/2014/11/13/india-potential-to-dramatically-reduce-stunting-in-children-new-world-bank-report.
[5] http://siteresources.worldbank.org/NUTRITION/Resources/281846-1271963823772/India.pdf.
[6] R. Oniang'o, Special issue devoted to biofortification, Afr. J. Food Nutr. Sci. 17 (2) (2017), http://www.ajfand.net/Volume17/No2/index.html.
[7] S. Lockyer, A. White, J.L. Buttriss, Biofortified crops for tackling micronutrient deficiencies – what impact are these having in developing countries and could they be of relevance within Europe? Nutr. Bull. 43 (4) (2018) 319–357 (Wiley Online Library).
[8] J.L. Finkelstein, S. Mehta, S.A. Udipi, P.S. Ghugre, S.V. Luna, M.J. Wenger, L.E. Murray- Kolb, E.M. Przybyszewski, J.D. Haas, A randomized trial of iron-biofortified pearl millet in school children in India, J. Nutr. 145 (7) (July 2015) 1576–1581.
[9] S.P. Scott, L.E. Murray-Kolb, M.J. Wenger, S.A. Udipi, P.S. Ghugre, E. Boy, J.D. Haas, Cognitive performance in Indian school-going adolescents is positively affected by consumption of iron-biofortified pearl millet: a 6-month randomized controlled efficacy trial, J. Nutr. 148 (9) (September 2018) 1462–1471.
[10] Banerji, A., Birol, E., Karandikar, B., Rampal, J., Jul 31, 2016. Information, branding, certification, and consumer willingness to pay for high-iron pearl millet: evidence from experimental auctions in Maharashtra, India. Food Policy 62, 133-141.
[11] http://gldc.cgiar.org/committed-to-alleviating-malnutrition-india-declares-minimum-levels-for-iron-and-zinc-in-pearl-millet/.
[12] https://www.harvestplus.org/knowledge-market/in-the-news/committed-alleviating-malnutrition-india-declares-minimum-levels-iron.
[13] S. Sazawal, U. Dhingra, P. Dhingra, A. Dutta, S. Deb, J. Kumar, P. Devi, A. Prakash, Efficacy of high zinc biofortified wheat in improvement of micronutrient status, and prevention of morbidity among preschool children and women - a double masked, randomized, controlled trial, Nutr. J. 17 (2018) 86 2018.
[14] https://www.harvestplus.org/knowledge-market/in-the-news/committed-alleviating-malnutrition-india-declares-minimum-levels-iron.
[15] M. Brnić, R. Wegmüller, A. Melse-Boonstra, T. Stomph, C. Zeder, F.M. Tay, R.F. Hurrell, Zinc absorption by adults is similar from intrinsically labeled zinc-biofortified rice and from rice fortified with labeled zinc sulfate, J. Nutr. 146 (1) (2016 Jan 1) 76–80.
[16] J.L. Rosado, K.M. Hambidge, L.V. Miller, O.P. Garcia, J. Westcott, K. Gonzalez, J. Conde, C. Hotz, W. Pfeiffer, I. Ortiz-Monasterio, N.F. Krebs, The quantity of zinc absorbed from wheat in adult women is enhanced by biofortification, J. Nutr. 139 (10) (2009 Oct 1) 1920–1925.
[17] S. Scott, L. Murray-Kolb, M. Wenger, S. Udipi, P. Ghugre, J. Haas, Cognitive performance in Indian school-going adolescents is positively affected by consumption of iron-biofortified pearl millet: a 6-month randomized controlled efficacy trial, J. Nutr. 148 (9) (2018) 1462–1471, https://doi.org/10.1093/jn/nxy113 2018 Sep. 1.
[18] https://www.fssai.gov.in/home/fss-legislation/fss-regulations.html.
[19] Food safety and standards (packaging and labelling) regulations, (2011).
[20] http://www.fao.org/ag/humannutrition/33309-01d4d1dd1abc825f0582d9e5a2eda4a74.pdf.
[21] S. Lockyer, A. White, J. Walton, J.L. Buttriss Nutrition Bulletin (Eds.), Proceedings of the 'Working Together to Consider the Role of Biofortification in the Global Food Chain' Workshop, 2018, pp. 416–427 First Published: 8 November.