Biofortification in Ethiopia: Current challenges and opportunities

EXECUTIVE SUMMARY

Biofortification, which involves enriching staple crops with micronutrients, is a relatively recent intervention that can complement existing interventions such as supplementation and fortification implemented to control micronutrient deficiencies. This study intended to explore barriers to the production and consumption of biofortified crops in Ethiopia and to highlight mechanisms by which biofortification can reduce micronutrient deficiencies. Using interviews and data analysis, we found biofortification to be a cost-effective intervention that can address inequities in micronutrient deficiencies among rural residents and those in lower levels of socioeconomic status. Perhaps most importantly for implementation, biofortification does not require consumers to change food consumption patterns. However, a significant barrier to the scale-up of biofortification is the absence of financial resources and complementing inputs in Ethiopia to support implementation. Institutionally, the lack of mandate to a specific organization to coordinate biofortification activities also limits the implementation of coordinated and collaborative actions. One of the most critical factors contributing to Ethiopia's low adoption of biofortified crops is the limited availability of improved seeds, mainly due to the poor seed supply system. Hence, access to biofortified seeds should be improved along the Ethiopian seed system value chain. Additionally, the introduction of biofortified crops should be targeted, considering existing food consumption patterns and, biofortification activities outlined in the National Food and Nutrition Strategy should be implemented.

Photo credit: HarvestPlus/2009

THE PROBLEM

Globally more than two billion people suffer from micronutrient deficiencies, which have long-lasting health and economic consequences[1,2]. In 2016, 14% of Ethiopian children under five years were vitamin A deficient, indicating that vitamin A deficiency is a moderate public health problem in the country[3]. Additionally, 35% of pre-school children and 34% of women are zinc deficient[3]. The major consequences of micronutrient deficiencies include impaired physical and cognitive development, increased risk of morbidity, low educational attainment, reduced work productivity and earning potential[1].

The World Health Organization (WHO) and Food and Agriculture Organization (FAO) recommend four main strategies for controlling micronutrient deficiencies; dietary diversification, fortification, supplementation, and nutrition education[4]. Biofortification involves the improvement of the nutritional quality of crops through breeding[5]. It is a relatively recent intervention that complements food

fortification and supplementation to control micronutrient deficiencies. Biofortification is also consistent with the efforts to make agriculture nutrition-sensitive and is considered the most cost-effective and equitable intervention currently in use. In Ethiopia, vitamin A supplementation for preschool children and iron/folic acid supplementation for pregnant women are being implemented at scale[6]. However, the coverage of these programs is low. Ethiopia also recently approved mandatory fortification for wheat flour and edible oil. However, fortification will mainly reach urban residents, creating inequities in access to micronutrient fortified foods[7]. Consequently, strategies that complement these intentions, such as biofortification, are needed.

The main objectives of this brief are;

- To highlight pathways through which biofortification can reduce micronutrient deficiencies in Ethiopia; and
- To describe bottlenecks to the production and consumption of biofortified crops.

BOX 1: METHODOLOGY

Review of literature: We summarized available literature to map pathways through which biofortification can be used to control micronutrient deficiencies. Literature was searched between July and December 2021 using Google Scholar. The review included published research manuscripts and gray literature, including policy and strategic documents, reports, working papers, and conference proceedings.

Key informant interviews: We conducted several key informant interviews to assess the state of biofortification in Ethiopia. Key informants were drawn from the Ethiopian Institute of Agricultural Research (EIAR), Ministry of Agriculture, International Potato Center (CIP), International Maize and Wheat Improvement Center (CIMMYT), and HarvestPlus.

Secondary data sources

To describe the total area under production with crops that have the potential to be fortified (bio-fortifiable), we used data from the Annual Agriculture Sample Survey (AgSS) (2015-2019)[8-10] as well as data from the 2015/16 Ethiopian Household Consumption and Expenditure Survey (HCES)[11] to show the importance of biofortifiable items in total consumption.

KEY FINDINGS

1. Benefits of biofortification

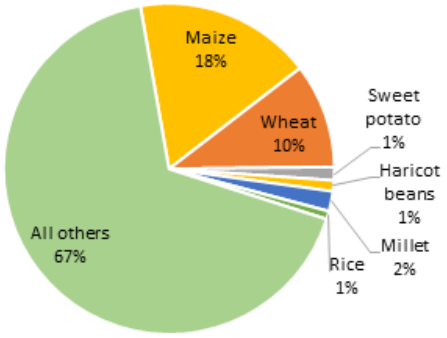
BIOFORTIFICATION CAN BE USED TO ADDRESS MICRONUTRIENT DEFICIENCIES IN RURAL AREAS

Existing micronutrient interventions such as fortification of wheat flour and oil mainly reach urban residents[7]. Most of the Ethiopian population lives in rural areas, primarily engaged in crop production for household consumption. Thus, the biofortification of staple crops is an intervention that can address this urban-rural access inequity. Moreover, most rural residents are poor and consume diets that are low in micronutrient-rich foods. Biofortification is an equitable intervention that can address economic disparities in the affordability of nutritious foods[5].

BIOFORTIFICATION IS A COST-EFFECTIVE INTERVENTION

Although supplementation is an effective short-term intervention to address micronutrient deficiencies, it is expensive and coverage remains relatively low in Ethiopia. Biofortification can be used to complement supplementation and fortification as it has the potential to reach populations with limited access to existing interventions[12]. Potentially bio-fortifiable crops are already the main contributors to the dietary intakes of Ethiopians. Maize and wheat accounted for nearly 30% of the food consumed in 2016 (Figure 1).

Figure 1: Total consumption of bio-fortifiable crops, 2016



BIOFORTIFICATION IS SUSTAINABLE

Another unique advantage of biofortification is sustainability. After an initial investment in developing biofortified varieties, the seeds fortify themselves. The biofortified trait will be carried forward. This multiplier aspect makes biofortification more sustainable than other nutritional interventions that involve higher annual costs[13].

BIOFORTIFICATION DOES NOT CHANGE FOOD CONSUMPTION PATTERNS

Foods biofortified with iron and zinc have no noticeable change in color, taste, odor, texture, or cooking qualities. Thus, no modification in food consumption patterns is required, making promoting the production and consumption of biofortified crops easier[14]. However, crops that are biofortified with vitamin A obtain a deep orangish color, requiring a different approach to promote production and consumption[15].

BIOFORTIFIED CROPS HAVE HIGH PRODUCTIVITY AND YIELD

Biofortification of seeds, among others, improves root penetration, increases the uptake of nutrients, and enriches trace metal deficient soils[13,16,17]. Thus, biofortified crops are more drought-resistant, require less irrigation and chemical fertilizer, have a higher rate of seedling survival, and have rapid initial growth[13,17]. Consequently, biofortification increases crop yields and lowers input costs[16].

2. Bottlenecks to scale up biofortification

LACK OF FINANCIAL RESOURCES FOR RESEARCH

Limited financial resources are available to *fund research with, well*-equipped laboratories needed at later stages of biofortification. The lack of such resources affects research capacities and the development of improved biofortified varieties in Ethiopia.

NO SPECIFIC ORGANIZATION COORDINATES BIOFORTIFICATION ACTIVITIES

The absence of an organization that oversees biofortification activities in Ethiopia limits effective coordination and collaboration between governmental and non-governmental actors. Consequently, advocacy for financial resources is limited, and public-private sector partnerships are not fostered.

THE SEED SUPPLY SYSTEM DOES NOT FUNCTION WELL

One of the most critical factors contributing to low improved seed adoption in Ethiopia is the unavailability or untimely availability of improved seeds, mainly due to the poor seed supply system. The current Ethiopian seed system cannot support scaled-up production of biofortified crops. Currently, the small number of seed producers limits access to seeds by farmers throughout the country.

Low production creates seed shortages, and seeds cannot be accessed in time for planting, which has significant challenges for Ethiopia. Additionally, seed systems are not decentralized, and there is a lack of coordination between seed developers, producers, and demand analyzers. In the case of orange flesh sweet potatoes (OFSP, it is impossible to supply planting materials without a decentralized seed production because OFSP vines must be planted within a few days.

BIOFORTIFIED CROPS DO NOT ALWAYS COMBINE IMPORTANT FEATURES SUCH AS YIELD AND NUTRITIONAL QUALITY

Crop traits, such as yield, insect resistance, drought tolerance, moisture content, sweetness (for OFSP), period to maturity, and features during processing/cooking influence adoption. Farmers and consumers cite the texture and odor of biofortified varieties for lower adoption. Adoption can also be adversely affected if the biofortified varieties need more complementary inputs and post-harvest handling.

BIOFORTIFIED CROPS SHOULD HAVE THE SAME SENSORY APPEAL AS CONVENTIONAL CROPS TO FACILITATE ADOPTION

Sensory characteristics, such as taste, color, and texture, influence the adoption of biofortified crops. Additionally, the sensitivity of taste, expectations, and food recipes used to introduce new varieties influence adoption. A common bottleneck to adopting vitamin A fortified crops is the orangish color.

INFORMATION ON BIOFORTIFIED CROPS IS NOT ADEQUALITY PROVIDED TO FARMERS

The adoption of biofortified seeds increases with access to information on benefits through informal communications, social networks, cooperatives, credit, and saving groups.

LIMITED ACCESS TO INPUTS, CREDIT, AND MARKETS RESULTS IN LOW ADOPTION

Farmers with better access to inputs used in producing biofortified crops, such as farm credit, labor, farm machinery, storage, and distribution facilities, are more likely to adopt. Furthermore, access to stable markets facilitates adoption, while the inability to get price premiums for biofortified varieties constrains adoption.

Box 2: Description of current state of biofortification in Ethiopia

Crops and nutrients: Current biofortification research in Ethiopia is focused on enriching five crops with three micronutrients. Iron and zinc beans, vitamin A biofortified OFSP, and Quality Protein Maize (QPM) have been released in the last decade. However, research on QPM has stagnated in recent years, mainly due to a lack of funding. Key informants indicated that biofortified varieties of maize and wheat enriched with vitamin A, iron, and zinc would be released soon.

Main actors: The national and regional centers of the Ethiopian Institute of Agricultural Research (EIAR) are the leading biofortifying institution for most crops. Biofortified OFSP varieties are developed by Hawassa Agricultural Research Center and International Potato Center. Research on QPM was undertaken by International Maize and Wheat Improvement Center (CIMMYT) during 2013-2019. Further, HarvestPlus is engaged in collaborative research and advocacy of biofortified crop varieties

Recent policy documents that address biofortification

Ethiopia's National Nutrition Program (NNP-II) (2016-2020): had specific objectives and government activities on biofortification, including an ambitious plan to establish a biofortification center. However, the NNP-II did not include biofortification indicators in the results and accountability matrix for implementation follow-up.

The National Nutrition Sensitive Agriculture (NNSA) Strategy (2017): the strategy does not contain detailed objectives and activities like the NNP-II. But it does include a way to monitor progress in biofortification.

National Food and Nutrition Strategy (2021-2030): the document mainstreams biofortification in production, consumption, and nutritional communication. However, the document lacks focus on the future development of biofortified varieties. It also is not well informed on the types of crops to be biofortified.

Game-Changing Solutions to Transform Ethiopia's Food System (2021): the document includes biofortification in the list of Game Changer solutions to transform food systems. It reflects the most current state of thinking among policymakers. However, the contrast of biofortification to fortification erroneously suggests that the former is an extension of industrial food fortification. Furthermore, there are no details on how biofortification will be implemented.

ACTIONS TO INCREASE PRODUCTION AND CONSUMPTION OF BIOFORTIFIED FOODS IN ETHIOPIA

ACTION 1: IMPROVE ACCESS TO BIOFORTIFIED SEEDS

Access can be improved by;

- Increasing the number of seed producers by incentivizing entry to the seed production subsector through tax, investment, and import policies. Providing loans to and organizing small-scale seed producers can also increase the number of seed producers.
- Decentralization of seed production may also enable the promotion of localized improved varieties.

  Identifying and implementing strategies to improve the lack of coordination between seed developers, seed producers, and seed demand analyzers. Improving operational capacities of existing institutions/mechanisms or creating new ones will help coordinate the activities of these agents and reduce the time lag from production to adoption of seed varieties. Furthermore, an information platform that can be shared by the agents to facilitate improved coordination.

ACTION 2: PROMOTE THE BENEFITS OF BIOFORTIFIED CROPS BY IMPLEMENTING SOCIAL BEHAVIOR CHANGE COMMUNICATION (SBCC).

Effective social behavior change interventions that reinforce individual communication with community mobilization and mass media messages can increase the production and consumption of biofortified foods. Such SBCC interventions should consider social contexts and engage local stakeholders from design to implementation.

ACTION 3: INTRODUCE BIOFORTIFIED CROPS FOR TARGETED POPULATION GROUPS AND AREAS

Acceptance of specific varieties of biofortified crops may require the segmentation of the target audience by residence (urban-rural populations), region, eating habits, access to markets. a Thus, biofortified crop promotion strategies should be context specific.

ACTION 4: IMPROVE SENSORY CHARACTERISTICS OF BIO FORTIFIABLE CROPS

To improve the sensory characteristic of biofortified crops, breeders should involve consumers during the development of biofortified varieties. Also, it is important to work with health and food science experts to develop recipes that fit cultural/local contexts.

ACTION 5: ADVOCATE FOR THE IMPLEMENTATION OF BIOFORTIFICATION ACTIVITIES OUTLINED IN THE NATIONAL FOOD AND NUTRITION STRATEGY

Ethiopia's National Food and Nutrition Strategy identifies the development and promotion of the production of biofortified crips as a strategic action to improve the availability of nutritious foods. Thus;

- Biofortification stakeholders should advocate for implementing this and other actions outlined in related policy documents.
- There is a need to identify an institution that coordinates the activities of different stakeholders engaged in biofortification to create accountability.

Further Information

The research report from which information for this brief was drawn will be available on the NIPN website soon (http://www.nipn.ephi.gov.et/). Detailed descriptions of findings and statistical methods used are included in the research report.

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