# BIOFORTIFICATION

## ACTION AGAINST HUNGER'S OPERATIONAL RECOMMENDATIONS



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## 1. BACKGROUND

According to recent FAO estimates, nearly **690 million people in the World are hungry** (FAO, IFAD, and WFP, 2020)[1]. Globally, the burden of malnutrition in all its forms remains a challenge: 144 million of children under 5 years of age were stunted, 47 million wasted and 38.3 million overweight.

One form of malnutrition is expressed in **micronutrient deficiencies**. Micronutrient deficiencies afflict more than two billion individuals, or one in three people globally, causing weakened immune systems and avoidable health outcomes, including blindness, delayed growth and cognitive and physical development. Humans require various nutrients (vitamins and minerals) in adequate amounts to live healthy and productive lives. Of these nutrients, four are in chronically short supply among economically disadvantaged communities: **iron, zinc, iodine and vitamin A**. Shortage of these micronutrients can have significant consequences on human health and development, causing a wide range of physiological impairments, leading to reduced resistance to infections, metabolic disorders, and delayed or impaired physical and psychomotor development.

Because of **societal and health implications** of micronutrients deficiencies, there is a heightened interest within development institutions, governments, NGOs, and scientific community about the need to seek for solutions to addressing micronutrients deficiencies. Different approaches are being put forward to tackle micronutrient deficiencies. These include diet diversification, biofortification, food fortification and supplementation.

Action Against Hunger (AAH) has developed **operational guidelines on food fortification**[2]. The present paper is about AAH operational guidelines on biofortification. These operational guidelines complement the existing AAH Position Paper on GMO Seeds and Foods, according to which AAH strongly exclude the provision and distribution of GMOs seeds in its operational programs.

[1] FAO, IFAD, UNICEF, WFP and WHO. 2020. *The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets*. Rome, FAO

[2] AAH operational guidelines on fortification.

# 2. WHAT IS BIOFORTIFICATION?

**Biofortification** gathers different processes and methods to **increase the density of vitamins and minerals** in the edible parts of the crops, or reduce anti-nutrients, so as to **improve the nutritional quality of the food supply**. Some stakeholders and promoters of biofortification believe that focusing on genes coding for essential nutrients is a promising route for addressing micronutrient deficiencies in developing countries. Some others consider it as 'false solution', that are risky, expensive and short-terms.

There are currently **three main methods** associated with biofortification:

1. **Conventional biofortification** uses conventional breeding techniques, i.e., the development of new varieties (cultivars) of plants by using **natural selection** to improve a desired genetic trait of a given crop variety. It is about manipulating plant genome within the natural genetic boundaries of the species.

2. **Agronomic biofortification** is done through **direct fertilization of the soil** with essential minerals, or through pulverization on the crop leaves.

3. **Biofortification using new genetic engineering techniques** aims at directly introducing desired genes, and related micronutrient dense traits, into a host **genetic code**, thus modifying it.

As such, biofortification involves either conventional plant breeding, the use of genetic engineering techniques or agronomic practices.

# 3. CURRENT BIOFORTIFICATION INITIATIVES

Biofortification initiatives are being developed and implemented through the **international alliance of HarvestPlus**[3] with the aims to improve Iron, Zinc and Vitamin A status among lower-middle income populations; a few key players dominate the market of biofortification and those promoters of biofortification produce most available literature about experiments.

Several biofortification initiatives are ongoing around the world covering **different food crops** and targeted micronutrients. Staple foods recognized as vehicles for the biofortification of specific micronutrients and targeted countries are given in the table below (Siwela et al., 2020)[4].

***Table 1.*** *Biofortification: targeted micronutrients, staple crops and countries*

| Target micronutrients | Staple crops | Targeted countryw |
|---|---|---|
| Vitamin A | Orange-fleshed sweet potato | South Africa, Uganda, Mozambque |
| Vitamin A | Maize | Nigeria, Zambia |
| Vitamin A | Cassava | DRC, Nigeria |
| Iron | Common bean | DRC, Rwanda |
| Iron | Pearl millet | India |
| Zinc | Wheat | India, Pakistan |
| Zinc | Rice | India, Bangladesh |

**In the past 20 years**, biofortification strategy has received considerable scientific and market attention as it is presented with **promising arguments** as a new way to end hunger in the world. As such agricultural research organizations have made biofortification a **priority** and donors are investing a lot of funds in this area, but, without necessarily the promising results from such investment.

Globally, biofortified crops have been released in **40 countries**, covering Africa, Asia and Latin America. The argument that it is an **inexpensive way** to fight malnutrition and its potential to effectively **complement other strategies** (such as food fortification[5], food supplementation and food diversification) seems to have convinced governments.

[3] HarvestPlus is a joint venture between the International Center for Tropical Agriculture (CIAT) and International Food Policy Research Institute (IFPRI).

[4] Siwela M, Pillay K, Govender L, Lottering S, Mudau FN, Modi AT, Mabhaudhi T. *Biofortified Crops for Combating Hidden Hunger in South Africa: Availability, Acceptability, Micronutrient Retention and Bioavailability.* Foods. 2020; 9(6):815. https://doi.org/10.3390/foods9060815

[5] AAH has also developed operational guidelines about food fortification. Refer to it for further details.

# 4. MAJOR CONCERNS AND RISKS ABOUT BIOFORTIFICATION

As promising as it is, biofortification strategy entails **important concerns**. Indeed, while biofortification is contemplated as a potential powerful tool to increase dietary intake of essential nutrients in staple foods, i**ts overall potential in reducing micronutrient deficiency is still to be proven**. To date, the only **Orange Fleshed Sweet Potato** (OFSP) has demonstrated its efficacy as an effective tool for tackling vitamin A deficiency in children and women of reproductive age[6].

The following are the **main potential risks and concerns** related to biofortification strategy:

- Much more work still needs to be done before **the efficiency and effectiveness** of biofortified crops are proven, as most source of information and studies mainly come from biofortified crop producers.
- Current concerns about their **safety, cost and impact on the environment** and farmers' seed security issues are still need to be alleviated (WHO and FAO, 2015[7]; Ceccarelli, 2014[8]).
- There is growing concerns that biofortification is contributing to the **neglect of food-based approaches** that depend on access to and consumption of the diverse crop varieties, and plant and animals species, available within local environments and food cultures.
- If solely prioritized, biofortification could be seen as another "technical fix and a **top-down approach** to the problem of micronutrient deficiencies, offering a **centralized, single-factor solution** that may fail to address social, economic, cultural and political determinants underpinning food systems.
- Biofortification strategy potentially **undermines dietary diversity**, addressing only one type of micronutrient deficiency and not different micronutrient simultaneously, by concentrating on a few staple foods, further simplifying diets too-often overly dependent on **a limited number of carbohydrates**. This diet not only leads to micronutrient deficiencies, but also contributes to diet-related illnesses.
- Because of its focus on **very limited staple crops**, biofortification could be **a threat to the genetic diversity of crops**, whereas there may exist a few tens of varieties of a species in a given country. Morever, it remains difficult to control **seed quality and quality** of end-product of biofortified crops.
- Potential risk for peasant farmers to **lose control on their peasant seeds** over the long term, thus become dependent of private firms for multiplying their seeds and planting materials.
- Biofortified crops might **not be acceptable** by farmers and consumers (paid access to seeds and planting materials, taste preference, color, cooking properties etc.).

[6] https://www.cgiar.org/innovations/biofortified-orange-fleshed-sweetpotato/
[7] WHO and FAO, 2015. *Guidelines on food fortification with micronutrients.*
[8] Ceccarelli, S., 2014; *GM Crops, Organic Agriculture and Breeding for Sustainability.*

- Due the debate and controversies surrounding non-conventional biofortification, and particularly the one using genetic engineering techniques, biofortified crops are **less socially acceptable** (FAO, 2015)[9].

- Concerns about **nutrient stability** remain very crucial since not all of the micronutrients are bioavailable to humans who eat these foods (Howarth et al., 2010)[10]. **Nutrient bioavailability** is defined as the fraction of a nutrient in a food that is digested, absorbed and utilized through normal pathways in the body or available for utilization or storage. Consequently, it is not enough to know how much of a nutrient is present in a given biofortified crop, the more important issue is **how much of that nutrient remains bioavailable**. It remains important to ascertain to what extent the modified nutrient remains stable with time, processing, and storage.

Due to those **different concerns**, it is necessary to support **less risky solutions** (for the environment and health), **affordable and that where prove efficient**, such as peasant seeds. It is necessary to have a **holistic approach** to hunger and enable access to **food diversification** (support local market and family farming, support agroecology and peasant seeds).

[9] FAO, 2015. *The role of biofortification in food-based approaches for addressing micronutrient deficiencies and key issues to consider when developing policies and programs related to biofortification*

[10] Howarth E. Bouis and Ross M. Welch, 2010. Biofortification - A Sustainable Agricultural Strategy for Reducing Micronutrient Malnutrition in the Global South

# 5. OPERATIONAL RECOMMENDATIONS FOR FIELD STAFFS

With the above concerns and risks in mind, there is a need to develop AAH operational recommendations to guide field staffs on the **criteria and conditions** to consider when it comes to the promotion and distribution of biofortified crops within AAH interventions. Considering the nature of our field operations, it is important to consider the biofortification under **the angle of both consumers and producers** as their needs and aspirations might differ.

## *1. Shall we support the promotion/distribution of biofortified crops?*

**i.** In line and with compliance with AAH Position Paper on GMO Seeds and Foods the promotion of biofortified crops produced from **any genetic engineering techniques** shall be **fully rejected** as it goes against AAH position paper on GMOs. The support to the development of crops that are biofortified through the **agronomic biofortification** process shall be **rejected as well** as, agronomic biofortification involves the application of chemical fertilizers, and goes against AAH position on agro-ecology.

**ii.** Action Against Hunger encourages **dietary diversification** and the **promotion of indigenous crops that are rich in micro-nutrients** as the first resort food-based approach to address malnutrition. Crops biofortified using conventional breeding could be considered.

**iii.** While AAH will monitor any new scientific information on **other conventional biofortified crops**, the following are **key requirements** for AAH to adopt them:

- Efficiency and effectiveness demonstrated by at least 3 independent sources.
- Bio availability of biofortified crops should be at 25% above traditional crops.
- Capacity of farmer to share and multiply seeds and planting materials.

**iv.** Today, only the **Orange Fleshed Sweet Potato** (OSFP) meets the above criteria (for example, Iron rich beans meet some of these criteria but not all; and there is a caution around quality control and bioavailability of iron in biofortified beans).

**v.** AAH will apply a **precautionary principle** for any other conventionally biofortified crops other than OFSP, thus **not promoting any such crops** until the efficiency and effectiveness of these biofortified crops are proven and current concerns about their safety, efficacy, impact on the environment and farmers' right and seed security issues are alleviated. AAH will therefore **monitor and conduct a watchdog on scientific literature** to collect any new information on biofortified crops and update these operational recommendations, if need be.

## *2. Why AAH supports the promotion of Orange Fleshed Sweet Potato (OSFP)?*

**AAH will promote the Orange Fleshed Sweet Potato** (OSFP) because of a variety of reasons, detailed below.

**i.** AAH values the approaches of development that, while preventing malnutrition among vulnerable communities, increases their food security, the rights and freedom of the peasant farmers to produce their own seeds and planting materials, check their quality and exchange them with their peers. Unlike most biofortified crops, sweet potato is a **vegetatively propagated crop** that typically has a seed system that involves **small and informal actors**[11]. Risk of an **extensive control of the seed system** from private companies appears therefore lower.

**ii.** Despite the risks and concerns associated with biofortified crops, the Orange Fleshed Sweet potato (OFSP) scores **multiple advantages**: effective increased content in pro-vitamin A under conventional breeding techniques, demonstrated efficacy on the nutrition status[12], visible trait of vitamin A that make the quality control of its multiplication by the farmers themselves possible. As such, based on the existing knowledge, AAH can therefore continue its support to the development and dissemination of OFSP.

## *3. What criteria and principles to consider in promoting biofortified Orange Flesh Sweet Potato in AAH interventions?*

**iii.** **Proper needs analysis and program design**: support to OFSP development should always be based on a **sound analysis and in-depth assessment** of real nutritional needs to confirm the prevalence of key micronutrients deficiencies, and particularly Vitamin A.

**iv.** **Biofortification activities shall be explicitly articulated with other strategies**, such as **food fortification** or **micronutrient supplementation** – to adverse the risk of neglecting other food-based approaches and to assure access and consumption of diverse crop varieties as well as addressing a large scope of micronutrient deficiencies; while assuring there is **no duplication of activities** to prevent the risk of excessive intake of micronutrients (knowing the fact that your program is rarely unique and other stakeholders usually provide assistance to the same population groups. It means that program design should be based on a sound knowledge of the other related initiatives that are accessible to our target groups).

**v.** ***Do no harm* approach 1**: Biofortification strategies appear to be counter to increasing dietary diversity. Biofortification as a strategy that aims to concentrate more nutrients in a few staple foods may contribute to further simplifying diets already **overly dependent on a few carbohydrate staples**. In poor countries, biofortification requires **increased public investments** in agriculture research and infrastructure for success. It directly **competes with other strategies**, particularly with food diversification.

11 Planting materials are perishable, expensive and bulky to transport over long distances, and must be replanted within several days after harvesting. The lack of commercial private sector participation creates both a challenge and an opportunity. However, cautious is still needed as current practices show that farmers are now purchasing additional stems from commercial traders, following distribution of free bundles and stems.

12 However, efficacy studies have still not demonstrated their impact onto the children under 3 years of age.

As a result, AAH requires that interventions with biofortified OFSP should always been incorporated in larger programs supporting crop diversification and the intake of a diversified diet.

***Do no harm* approach 2**: The production and promotion of a few biofortified crop varieties may undermine another fundamental development goal to **conserve and use biodiversity** for addressing multiple human needs. Situation might be risky as well for Sweet Potato. As a result, AAH should rather support the farmers in disseminating their peasant seeds for the sake of seeds diversity, through **seeds fairs** than promoting certified biofortified crops. The conservation of existing local varieties of sweet potatoes appears important as well.

**vi. Support the supply side, observing agroecology practices**: To support the dissemination of OFSP vegetative materials to farmers, AAH may engage in **developing experiment plots** to ensure effective backcrossing OFSP with locally adapted varieties; and ensure OFSP are **adapted to local stresses and pests**. To this regard, AAH may be developing **training materials**, where necessary, in local languages to ensure farmers apply good practices.

As a reminder, recommended practices should always **observe the agro-ecology approach**, and particularly the following **crop cultivation conditions**, where applicable: zero or reduced use of synthetic fertilizers and use of animal manure and compost instead, zero or reduced use of pesticides and use of alternative techniques (hand-picking, biopesticides, crop associations, crop rotation, etc.) instead, increased recourse to crop-livestock associations, zero or minimum tillage, use of local varieties, etc. Select the distribution modality that mostly **empowers small-scale farmers**. According to contexts, dissemination might appear to be direct distributions, seeds fair or cash based programming.

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### *4. How should we support consumption of biofortified Orange Flesh Sweet Potatoes?*

**vii.** Activities that support the demand creation for OFSP may be essential to ensure good acceptance by the farmers and consumers. As a result, AAH may implement **nutrition education activities**, **cooking demonstration sessions**, as well as **social marketing**.

**viii.** OFSP must observe and **respect local socio-cultural preferences** with respect to food. AAH might also train value-chain stakeholders about the benefits of the OFSP, particularly shopkeepers to ensure better acceptance. **Shopkeepers and retailers** should also receive ad-hoc training about biofortified products good storage practices and uses. Shopkeepers should agree to deliver essential messages about biofortified food uses to their clients.

## *5. Shall we distribute biofortified foods to our beneficiaries in emergency programming?*

**ix.** In emergency programming, **free distributions of biofortified food** can be acceptable depending on the type of biofortification method used and level of acceptance by local population but they are generally **not recommended** for several reasons explained above. There are in theory no particular restrictions with regard to biofortified foods obtained through conventional breeding techniques or agronomic practices. Usual recommendations about **food quality** apply. However, since the information about the production process will not be available in many instances, extreme caution shall be observed, as biofortified food might have been obtained through new genetic engineering techniques. **Information regarding breeding techniques** should be asked and **special precaution** should be taken in case of no information available.

**x.** Prior any bulk purchase of biofortified foods from your supplier, it is essential to **check the characteristics of the grains** and **receive details about the production process and breeding techniques** used. Appropriate communication with the logistics department is therefore instrumental. If new genetic engineering techniques have been used, you need to refer to **AAH position paper on GMO**[13]. Strict adherence to GMO position paper is critical to avoid GMO food is used as seeds. If no information is available about the food production process, recommendation is to apply the GMO position paper, milling the grain prior to distribution (where feasible), or select another supplier that can provide detailed information, or select non-biofortified food.

**xi.** Biofortified foods positively affect nutrition, only if the consumption is sustained, usually **daily over a prolonged period**. Most trials involved daily feeding over several months. Free distributions of biofortified foods would therefore only have a chance to significantly affect the human health if done during protracted crises, in situations where recipients of food aid would benefit from the aid over a long period. In other situations, there is no strong rationale, apart from food availability, to prefer biofortified foods to non-biofortified ones. As result, while the distribution of biofortified foods is acceptable, we are questioning the **relevance**.

**xii.** Whenever distributing biofortified foods, you shall **inform the recipients** about the nutrient characteristics of the foods, as well as the good storage and cooking practices.

**xiii.** **Usual good practices and recommendations** during food distributions also apply to biofortified foods. For instance, it is critical to conduct systematic monitoring about biofortified food uses amongst end users, as well as the evolution of the diets of the targeted communities.

[13] AAH Position Paper on GMO Seeds and Foods


## *6. Red lines for operations*

- No biofortification program, where there is access and consumption of diverse crop varieties allowing people to meet their nutrient needs naturally.

- **In-depth assessment of real nutritional needs** to determine the prevalence of key micronutrient deficiencies before embarking in any biofortification interventions. Moreover, when applicable, biofortification activities need to be **articulated with other strategies**, such as natural crop-based diet diversification.

# REFERENCES


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