UNITED REPUBLIC OF TANZANIA

MINISTRY OF AGRICULTURE

NATIONAL BIOFORTIFICATION GUIDELINES

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NUTRITION INTERNATIONAL
Nourish Life

NUDEC
NUTRITION, HEALTH AND DEVELOPMENT

HarvestPlus
Better Crops • Better Nutrition

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ABBREVIATIONS

ASDP	Agricultural Sector Development Program Phase II
BNFB	Building Nutritious Food Baskets Project
CSO	Civil Society Organizations
CIP	International Potato Center
DQS	Declared Quality Seed
FLAM	FAO Loss Assessment methodology
GMO	Genetically Modified Organism
IFA	Iron and Folic Acid
MoHCDGEC	Ministry of Health, Community Development, Gender, Elderly and Children
MITI	Ministry of Trade and Industries
MoA	Ministry of Agriculture
MoW	Ministry of Water
NBS	National Bureau of Statistics
NMNAP	National Multi-sectoral Nutrition Action Plan
NARES	National Agricultural Research and Extension System
NFFA	National Food Fortification Alliance
OFSP PHL	Orange Fleshed Sweet Potato Post Harvest Losses
PHM	Post-Harvest Management
PORALG	President's Office Regional Administration and Local Government
QDS	Quality Declared Seed
SBCC	Social and Behaviour Change Communication
TBS TFNC	Tanzania Bureau of Standards Tanzania Food and Nutrition Centre
TOSCI	Tanzania Official Seeds Certification Institute
UN	United Nations
VAD	Vitamin A Deficiency
VAS VCU	Vitamin A Supplementation Value for Cultivation and Use
WHO	World Health Organization

FOREWORD

Malnutrition is one of the biggest public health Concern. It affects especially women of reproductive age and under five children. To a large extent, malnutrition is caused by nutrient deficiency. These nutrients include carbohydrates, proteins, fats, minerals and vitamins. Vitamin and mineral deficiencies have the greatest effect despite showing no visible effects to human body. The consequences of nutrient deficiencies include stunting (physical and mental), wasting, low birth weight, decreased immune function, blindness, infertility, anaemia and can lead to death in particular to pregnant women and children under five years.

According to TDHS-MIS 2015/16, 34% of under five children are stunted, 4.5 % are wasted and 14 % are underweight. In addition, anemia in women of childbearing age is 45% and for children it is 58%. This nutritional status is unsatisfactory and requires effective coping strategies.

The government has continued various efforts to address malnutrition. One such initiative is the implementation of the National Multisectoral Nutrition Action Plan (NMNAP 2016/17 - 2021/22) which covers various sectors. The Ministry of Agriculture through the Agriculture Sector Development Plan II (ASDP II), is responsible for ensuring the production, availability and utilization of a variety of food crops and especially biofortified foods with the aim of improving the nutrition status of the community.

Biofortification is one of the key strategies to overcome the challenge of nutrient deficiencies especially for vitamins and minerals. This method is used during crop production where seed breeding technologies are used. Studies show that biofortification is simple and cheap, thus can reach a large number of people in the community and bring immediate results.

At present, Tanzania does not have guidelines governing the implementation of various interventions related to biofortification. Thus, the Ministry of Agriculture in collaboration with other stakeholders has prepared this guideline to enable stakeholders to plan, implement and manage various biofortification initiatives. This guideline will be involving the entire value chain from seeds variety development, crop production, processing, storage, distribution and consumption

It is my hope that, this guideline will be used effectively and will contribute to the control of nutrient deficiencies in various age groups. This will enable the country to have healthy people who will actively participate in economic activities, including agriculture and thus contribute to national economic development and enable the country to enter the middle economy as the National Development Vision 2025 sets out.

Gerald M. Kusaya
Permanent Secretary
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GLOSSARY

Agricultural extension services

The application of scientific research and new knowledge to agricultural practices through farmer education

Agro-dealers

Agricultural input suppliers trained in business skills, agro product knowledge, safe handling and use of up-to-date technology. They are expected to provide basic extension services to farmers, creating an invaluable source of knowledge and advice for farmers.

Agro-inputs

Permitted products for use in farming systems including feedstuffs, fertilizers, plant protection substances as well as cleaning agents and additives used in food production.

Agronomic practices

Practices that farmers incorporate to improve soil quality, enhance water usage, manage crops and improve the environment.

Anti-nutrition factors

Biological compounds present in human or animal foods that reduce nutrient utilization or food intake, thereby contributing to impaired gastrointestinal and metabolic performance.

Bioavailability

The proportion of a drug or other substance which enters the circulation when introduced into the body and so is able to have an active effect. Rate of bioavailability depends on factors such as the composition of the diet. In nutrition, bioavailability is the degree to which food nutrients are available for absorption and utilization in the body.

Body Mass Index

Calculated by dividing weight in kilograms by the square of height in metres

squared (kg/m^2) whereby:

- <16 =severe underweight.
- 16-17=moderate underweight
- 17-18.5=mild underweight
- 18.5-25=normal
- >25=overweight
- >30=obese

Conventional plant breeding

The development or improvement of cultivars using conventional tools for manipulating plant genomes within the natural genetic boundaries of the species. It involves identifying and selecting desirable traits in plants and combining these into one individual plant. Plants from a given population that show desired traits can be selected and used for further breeding and cultivation.

Daily nutritional requirements

The levels of intake of essential nutrients that are considered adequate to meet the known nutrient needs of most health individuals.

Dietary modification

Changes made during food preparation, processing and consumption to increase the bioavailability of micronutrients and reduce micronutrient deficiencies in food at the commercial or individual/household levels.

Diversified diet/dietary diversification

An approach that aims to enhance the availability, access and utilization of foods with a high level of bioavailable micronutrient content throughout the year. It involves making changes to food production practices, food selection patterns and traditional household methods for preparing and processing indigenous foods.

Food safety

The proper handling, cooking and preservation of food to protect against foodborne illnesses caused by microbes such as viruses, bacteria, parasites and fungi.

Genetically modified varieties

Crops or plants used in agriculture with DNA modified through genetic engineering methods. In most cases, the aim is to introduce a new trait to the plant which does not occur naturally in the species.

Germplasm

A living genetic resource such as seeds or tissues from any other part of the plant (e.g. leaf, stem, pollen) that is maintained for the purpose of turning it into a whole plant. It contains the information for a species' genetic makeup, a valuable natural resource of plant diversity.

Hidden hunger

A chronic lack of vitamins and minerals (also called micronutrients) that often has no visible warning signs, so people who suffer from it may not even be aware of it. Its consequences are nevertheless disastrous; hidden hunger can lead to mental impairment, poor health and productivity, and even death.

Immune system

The system within the body involving organs and processes that provides resistance to infection and toxins. The organs involved include the thymus, bone marrow, spleen and lymph nodes.

Low birth weight babies

When an infant weighs 2,500 grams or less, regardless of the gestational age. Low birth weight can come about when full-term infants have undergone growth retardation in the womb or when infants are born prematurely (before the due date—see **premature babies/birth**).

Marker assisted selection

An indirect selection process where a trait of interest is chosen based on a marker (morphological, biochemical or DNA/RNA variation) linked to a trait of interest (e.g. productivity, disease resistance, abiotic stress tolerance and quality), rather than on the trait itself. This process has been extensively researched and proposed for plant and animal breeding.

Micronutrient malnutrition

Diseases caused by a dietary deficiency of vitamins or minerals.

Minimum acceptable diet

The indicator that measures both the minimum feeding frequency and minimum dietary diversity as appropriate for various age groups of children between 6-23 months of age who receive a minimum acceptable diet apart from breast milk.

Miscarriage

The spontaneous or unplanned expulsion of a fetus from the womb before it is able to survive independently. Some use the cut-off of 20 weeks of gestation, after which fetal death is referred to as a stillbirth.

Nutrition-sensitive agriculture

A food-based approach to agricultural development that puts nutritionally rich foods, dietary diversity and food fortification at the heart of overcoming nutritional deficiencies. The overall objective of nutrition-sensitive agriculture is to better equip the global food system to produce good nutritional outcomes

Premature babies/birth

A premature birth is birth that occurs before the start of the 37th week of pregnancy.

Supplementation

The preparation or addition of products to enhance the diet and provide nutrients, such as vitamins, minerals, fibre, fatty acids or amino acids, which may be missing or may not be consumed in sufficient quantities in a person's diet; these products are not considered to be food.

Value chain

A set of activities that a firm operating in a specific industry performs in order to deliver a desired product for the market. For firms that produce goods, a value chain makes up the steps involved in taking a product from conception to

distribution, and everything in between.

Vulnerable groups

Groups or sectors of society that are at higher risk of being subjected to discriminatory practices, violence, natural or environmental disasters, or economic hardship than other groups within the population especially during periods of conflict and crisis. The groups can include women, children and the elderly

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CHAPTER ONE: INTRODUCTION

1.1 Biofortification

The World Health Organization (WHO) describes biofortification as "the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding and genetic modification technology. Agronomic practices involve application of macro- and micronutrients in soils or in the foliage. Conventional plant breeding involves selective, intra-species breeding process where crosses are made naturally through pollination, when deoxyribonucleic acid (DNA) is transferred from one plant to another without an interspecies crossing barrier. Genetic modification technology involves the transfer of DNA between non-compatible species with crossing barriers; the process is done under laboratory conditions using in vitro technology without the natural system of pollination. Biofortified food crops that are already available in Tanzania were developed through conventional method.

1.2 Malnutrition and its associated challenges

1.2.1 The Role of Nutrients in the Body

The human body requires both macronutrients and micronutrients to sustain good health. Macronutrients namely carbohydrates, proteins and fats are the primary sources of energy for the body. Carbohydrates (starches and sugars) provide essential fuel for the body, while proteins build and repair body tissues and fats are rich energy sources. Macronutrient deficiency may cause undernutrition while excessive intake may cause overweight and obesity.

Micronutrients include vitamins and minerals. The body cannot produce these essential micronutrients and therefore, they must be supplied by the diet. The body needs micronutrients in very small amounts to ensure normal metabolism, growth and well-being. Vitamins are needed to build body tissues, metabolize food, prevent disease, promote immune function, and protect the overall health of an individual/nation. Minerals have three main roles a) building strong bones and teeth, blood, skin and hair; b) regulating transmission of signals by nerves; and c) metabolism, mainly changing food into energy and synthesis of proteins.

Some micronutrient deficiencies may not present as full-blown clinical effects but instead, contribute to sub-optimal health. Hence, the term "hidden hunger" is often used to describe them. The main micronutrient deficiencies of public health significance are vitamin A deficiency (VAD), iron deficiency and anaemia, iodine deficiency disorders, and zinc and folate/folic acid deficiencies (WHO 2006). This biofortification guideline focuses on vitamin A, iron, zinc, protein as nutrients of public health significance.

1.2.2 The Effects of Malnutrition

Malnutrition is primarily caused by insufficient quantity and quality of essential macro- and micronutrients to support healthy growth and functioning. It may also occur as a side effect of various diseases. The effects of nutrient deficiencies during the first 1,000 days of life (from conception to a child's second birthday) are of public health and economic significance (Scaling up Nutrition Initiative, 2010) as they may result in sub-optimal reproductive outcomes (e.g. miscarriages, premature or low birth weight babies) and maternal deaths, as well as having negative effects on cognitive and physical development of children. Nutrient deficiencies may also cause lowered immunity and can have a significant impact on increased morbidity and mortality. It has been established that 45 percent of childhood deaths especially from diarrhoea, malaria, pneumonia and measles are directly related to malnutrition (Black et. al, 2013). Moreover, nutrient deficiencies may be associated with irreversible cognitive impairment and lower educational attainment, as well as decreased work capacity and productivity, which may have negative consequences on economic and national development. Mild VAD is associated with night blindness, while severe VAD may lead to blindness.

1.3 Extent of Malnutrition

1.3.1 Global Malnutrition

According to the 2018 Global Nutrition Report, approximately 150.8 million (22.2 percent) children younger than five years are stunted, and 50.5 million (7.5 percent) are wasted. Approximately 462 million adults are underweight with a Body Mass Index (BMI) of less than 18.5. Altogether, micronutrient malnutrition is estimated to affect 2 billion people around the world. (Global Nutrition Report, 2018).

1.3.2 Malnutrition in Tanzania

Stunting, Wasting, Underweight and Overweight

The 2018 Tanzania National Nutrition Survey (TNNS) covered children aged 0-59 months and women of reproductive age (WRA) between the ages of 15-49 years. The survey revealed that approximately 31.8 percent of children were stunted, 14 percent were underweight, 3.5 percent were wasted, and 2.8 percent were overweight. Among WRA, 7.3 percent were underweight, while 31 percent were overweight, and 10 percent were obese (TNNS, 2018).

Anaemia

The Tanzania Demographic, Health and Malaria Indicator Survey (TDHMIS) 2015/16 showed that 58 percent of children between the ages of 6-59 months had anaemia while it was 45 percent for women of child of bearing age (WRA)

The main cause of anaemia is iron deficiency. Other causes include deficiency of other nutrients that play a significant role in manufacturing red blood cells—including proteins, copper, folate, vitamins A, B6, and B12. Other causes are malaria; intestinal worms especially hookworms, schistosomiasis, chronic diseases like HIV/AIDS and TB. Excessive bleeding and inherited diseases like sickle cell anaemia can also contribute to anaemia.

Vitamin A deficiency

Vitamin A deficiency (VAD) affects 33.5 percent of children aged 6-59 months and 35.9 percent of WRA (DHS, 2010). Although there is no recent national representative data on the impact VAD has on vision, mild VAD is associated with night blindness, while severe VAD may lead to blindness.

Zinc deficiency

A study of hospitalized children in Tanzania showed that zinc deficiency among children aged 6–59 months was as high as 70 percent (Veenemans *et al*, 2011).

1.3.3 Risk Factors for Nutrient Deficiencies

The main cause of nutrient deficiencies is inadequate intake of iron, vitamin A and zinc in food, coupled by frequent acute infections and chronic diseases. The underlying contributory factors are household food insecurity, poor dietary diversification, as well as inadequate knowledge about the different types of nutrient-rich foods and their preparation, and pre- and post-harvest management of crops. These food-based and behaviour-related factors are often coupled with inadequate access to water, sanitation, basic health and public services. Sociocultural factors contribute to sub-optimal caring and feeding practices. Low social positioning of vulnerable and marginalized groups, gender inequality and widespread hunger and poverty are the basic contributing factors to nutrient deficiencies in Tanzania.

1.3.4 Economic Implications of Malnutrition in Tanzania

The prevalence of all nutritional deficiencies reported herein is much higher than the WHO thresholds for major public health problems in a population. As well as affecting individuals, families and communities, malnutrition has a significant impact on the Tanzanian economy. Deficiencies in iron, vitamin A and folate alone are estimated to cost Tanzania over US$518 million, around 2.65 percent of the country's GDP (Vester *et al*., 2010). However, using DHS 2010 and other relevant sources of nutrition information for Tanzania, it is estimated that if the prevalence of iron deficiency anaemia can be reduced between 2014-2025, the economic productivity gains in adult women could be as high as US$382 million (Ash *et al*., 2014).

1.4 Rationale for Developing the Biofortification Guidelines

Guided by the Tanzania Development Vision 2025 of well-being and universal access to health for all people, the country has instituted several initiatives, programs and interventions to address malnutrition. These have been included in the National Multi-Sectoral Nutrition Action Plan (NMNAP 2016/17–2021/22), which enables both nutrition-specific and nutrition-sensitive interventions to be implemented synergistically. However, a recent study report by the Ifakara Health Institute revealed that the NMNAP is heavily inclined to health-focused, nutrition-specific actions, but only three of the 29 indicators are linked to food systems. There are two indicators on fortification and one on dietary diversity. However, there is no action linked to biofortification (Todd and Mamdani, 2017). Additionally, separate policies and strategic implementation plans have been instituted for all the micronutrient interventions, except for biofortification. Most of the initiatives involved micronutrient supplementation, for which sustainability is a challenge due high purchasing and implementation cost. In contrast, biofortification enable the community to produce biofortified crops with required micronutrients which readily available to the community at affordable price and in a sustainable manner.

Component three and four of the Agriculture Sector Development Plan II (ASDPII) have a major focus in nutrition. Therefore, the Ministry of Agriculture (MOA) is developing the current biofortification guidelines to enhance existing nutrition-related policies and implementation plans that currently have minimal coverage on biofortification. The biofortification guidelines will serve as a rich knowledge resource in the design and strengthening of biofortification interventions. The interventions will start with breeding of the desired seeds, crop production and will continue through processing, marketing, distribution and consumption. The guidelines will also integrate nutrition as a key component of agricultural interventions to generate innovations, evidence and learning to inform further decision-making actions for resource allocation.

Furthermore, the guidelines will contribute to the national strategy towards meeting the targets for the 2030 United Nations 17 Sustainable Development Goals (UNSDGS, 2025). The ambition to end hunger, achieve food security, improve nutrition and promote sustainable agriculture is captured in SDG 2 and at least 12 of the 17 SDGs contain indicators that are highly relevant to nutrition. The guidelines will also contribute to the nutrition targets articulated in the UN Decade for Nutrition 2016-2025.

Preventing and controlling micronutrient deficiencies will also have significant economic benefits in terms of improving educational attainment, reducing public expenditures on health, increasing adult labour productivity and eventually reducing poverty. These benefits will contribute considerably to the country's

drive towards industrialization and becoming a middle-income country as per Tanzania Development Vision 2025.

1.5 The Process of Developing the Guidelines

The biofortification guidelines were developed following all government procedures. The process was participatory, involving all key stakeholders at the national and sub-national levels. This was important for ownership and limiting duplication of efforts, as well as paving the way for utilization of the guidelines beyond dissemination. Essentially, the process included an inception meeting of various stakeholders, Technical Working Groups (TWG) and meetings with different experts from sectors and institutions responsible for nutrition and agriculture including Ministry of Agriculture, Ministry of Health Community Development Gender Elderly and Children, Ministry of Education, Ministry of Trade and Industry, Regulatory and Academic Institutions.

1.6 Guiding Principles

Implementation of these guidelines will be governed by a set of key principles, outlined below:

1.6.1 Universal Access: Equity and Right to Good Nutrition and Health

The guidelines are based on the UN global principle of universal access to quality food and nutrition services as well as Tanzania's Vision 2025 for improved health and quality of life. Equity is key in delivery of services to address micronutrient deficiencies, considering equal rights and avoiding discrimination on basis of social status, ethnicity, sex, disability, peer group and age.

1.6.2 Multi-Sectoral Approaches, Integration and Partnerships

Fostering collaboration and partnerships between nutrition-related stakeholders coupled with strong political leadership may catalyse the adoption of optimal nutrition practices and provision of services and interventions. Thus, interventions for prevention of and control of micronutrient deficiencies through biofortification shall be integrated into ongoing multi-sectoral nutrition interventions. Fostering public-private partnerships will also be among the key strategies in implementing the guideline.

1.6.3 Advocacy and Lobbying

The guidelines ask users to advocate and lobby for integrated packages and increased awareness creation and mobilization of resources/financing for biofortification interventions at all levels. They call for planning, monitoring and evaluation of advocacy efforts and enabling environment initiatives. Also, the guidelines should support both downstream and upstream stakeholders who are very influential in campaigning for access and use of nutrient-rich foods on an equal and equitable basis.

1.6.4 Gender and Cultural Sensitivity in Nutrition

It is common that gender norms and cultural practices influence uptake of nutrition programs by different communities. The biofortification guidelines will foster promotion and integration of gender and equity by identifying gaps in each geographical zone to facilitate efficient and effective implementation of the guidelines.

1.6.5 Delivery of Comprehensive Interventions

Implementation of the guidelines will focus on quality of interventions and accountability of implementers so impact will be achieved through evidence-based results and sustainable approaches that are easy to scale up.

1.6.6 Research and Development

Undertaking appropriate research studies to fill critical knowledge gaps in biofortification is key for consumers to access nutrient-rich foods in a sustainable, user-friendly and economically viable manner that meets with socio-cultural acceptance.

1.6.7 Monitoring, Evaluation and Learning

A robust monitoring, evaluation and knowledge management system will be sought to facilitate documentation of lessons learned, challenges, opportunities and models suitable for scaling up from best practices and innovations.

1.7 Scope of the Guidelines

The guidelines will cover the whole food chain from variety development to consumption of biofortified foods. The guidelines will address both macro and micro nutrients with an initial focus on three micronutrients (vitamin A, iron and zinc) and protein (lysine and tryptophan). The biofortification guidelines will complement existing micronutrient and related national guidelines and interventions

1.8 Target Audience

The current biofortification guideline aims to support the planning, implementation monitoring and evaluation of biofortification initiatives at all levels. The target audience includes all relevant public and private sector stakeholders involved directly or indirectly in the national food systems framework. The key target geographical areas shall be where biofortification can have impact, such as where prevalence of micronutrient deficiencies is high and crops to be biofortified are among the staple foods. In areas where malnutrition is predominant and biofortified crops can be grown but are not among the staple foods, efforts will be made to raise awareness on the benefits of cultivating such crops and consume food from biofortified crops.

1. 9 Purpose and Objectives

1.9.1 Purpose

The main purpose of the national biofortification guidelines is to contribute to national efforts to reduce nutritional deficiencies as a significant public health problem among vulnerable groups.

1.9.2 Main Objective

To contribute to improved health and nutrition status of vulnerable groups in Tanzania

1.9.3 Specific Objectives

i. To enable the country to produce specific biofortified crops with traits that will make vitamin A, iron, zinc, lysine and tryptophan available at the community level.
ii. To provide national guidance on the institution and implementation of biofortification initiatives in the context of nutrition-sensitive interventions of the NMNAP.
iii. To provide a framework for the planning, implementation, monitoring and evaluation of national biofortification initiatives and associated regulatory mechanisms.
iv. To foster partnership between the public and private sector, Civil Society Organizations (CSO) and communities in addressing malnutrition through dietary improvement using biofortified crops.

CHAPTER TWO: ANALYSIS OF EXISTING NUTRITION AND BIOFORTIFICATION INTERVENTIONS

2.1 Existing Interventions to Address Micronutrient Malnutrition and Challenges

The conceptual framework for implementation of nutritional interventions adapted for the NMNAP classifies them as nutrition-specific for example micronutrient supplementation, and nutrition-sensitive interventions example homestead food production, food fortification, biofortification, public health interventions including malaria control and prevention; deworming; prevention and control of HIV/AIDS Tuberculosis, provision of water, sanitation and hygiene services and behaviour change communication (BCC). (Appendix 1)

2.1.1 Supplementation

Micronutrient supplementation involves intentional provision of minerals and vitamins to a given population group for the purpose of supplementing the deficient nutrients. These include WHO's different supplementation schemes for VAD, iron deficiency, as well as multiple micronutrient deficiencies and zinc supplementation as adjunct to diarrhoea treatment with oral rehydration salts (ORS). Since 1987, high potency vitamin A capsules of 100,000 IU for children 6-11 months of age and 200,000 IU for older children up to 59 months are provided every six months. This approach has yielded high coverage with 75% of children aged 6-59 months having received vitamin A supplements in the six months preceding the 2015/16 DHS-MIS survey but decreasing to 63.8 percent in the 2018 TNNS. The decreasing trend creates need for other sustainable and affordable means to ensure availability of Vitamin A, such as production and utilization of Vitamin A rich foods at household level.

Iron and folic acid supplements (IFA) have also been instituted as a key component of antenatal services since the establishment of free maternal and child health services in the 1960s. In recent years, IFA has also been provided to adolescent girls in selected districts through partner funded projects.

Challenges with micronutrient supplementation:

- Unsustainable supplies of the commodities due to dependence on donor funds.
- Low compliance of IFA by users. For example, 2015/16 DHS-MIS reported that, although 81 percent of pregnant women had received IFA tablets, only 21 percent of women reported taking iron supplements for the recommended 90 days and 18.8 percent had not taken iron supplements at all.
- Inadequate accessibility of IFA and VAS in some areas due to deficiency of qualified service providers, lack of sustainable training to service providers and poor rural roads especially during rainy seasons.

2.1.2 Food-based interventions

The main strategy for improving the macro- and micronutrient nutritional status of Tanzanians has been food-based interventions (FBI) targeted to different age groups. Evidence of giving children a good start and ensuring adequate nutrients begins with the promotion of breastfeeding countrywide. The 2018 TNNS reported that 98 percent of children had been breastfed and 59 percent had been exclusively breastfed for six months. Feeding of young children from the age of six months with nutrient-rich complementary foods is also promoted countrywide. The 2015/16 DHS-MIS, and DHS 2010 revealed that 62 percent of children aged 6-36 months and 72 percent of women with a child younger than three years had consumed vitamin A rich food in the preceding 24 hours, but only 36 percent had consumed iron rich foods.

***Challenges with FBI**:*

- Persistence of sub-optimal infant and young child feeding practices especially during weaning due to inadequate nutritional knowledge among community members.
- Some rural populations have low household income, which means some are unable to purchase foods that they do not produce in their own farms. This is especially the case with seasonal crops, notably vegetables and fruits.
- Inadequate nutritional knowledge on food preparation and dietary diversification.
- Cultural factors that hinder consumption of some types of foods (e.g. consumption of eggs by pregnant women).

2.1.3 Agriculture-based interventions

These are interventions aiming at increased production of various food crops and food from animal source in order to enable the household to diversify their diets to improve their nutrition status. This can be done through promotion of fruits and vegetables through promotion of home gardening and production of biofortified crops such as orange - fleshed sweet potatoes (OFSP), iron and zinc beans and vitamin A maize; and rearing of small animals.

Challenges with agriculture-based interventions:

- High post-harvest losses especially of the fresh produce like fruits and vegetables.
- Inadequate promotion of micronutrient rich crops production such as fruits and vegetables

2.1.4 Food fortification

Food fortification, both industrial and home based, has been adopted as an approach to reach a large sector of the population through existing food delivery systems. The National Action Plan for the Provision of Vitamins and Minerals to

the Tanzanian Population (URT, 2016) through the Enrichment of Staple Foods is operational and coordinated through the National Food Fortification Alliance (NFFA).

***Challenges with food fortification*:**

- Dependence on imported food fortifiers makes the fortification interventions not sustainable.
- High prices of some of fortified foods example table salt causes low-income households not able to purchase them.
- Underutilization of fortified foods by many households in the rural areas due to the fact that most of them utilize food produced and processed locally.

2.1.5 Public health interventions

The main public health measures that contribute to the prevention and control of nutritional deficiencies—notably control of malaria, deworming and control of diarrhoea through safe water, sanitation and hygiene—have also been promoted countrywide. These have been addressed by the National Guidelines for the Preventing and Control of Micronutrient Deficiencies (unpublished MoHCDGEC, TFNC 2018). Controlling infections and infestations reduces the risk of micronutrient loss and increases the bioavailability and absorption of the nutrients consumed. The public health interventions have been successful to a large extent.

Challenges with public health interventions:

- The main challenge is public health interventions are resource-intensive and there is inequity in geographical distribution with a bias toward urban areas over rural areas.

2.2 Nutritional Principles for Biofortified Crops

Biofortification process must follow specific scientific procedures in order to get crops with required nutrients in required amounts. Availability of micronutrients in biofortified foods will depend on many factors such food processing, storage, crop variety, cooking methods, dietary intake and individual health among others as summarized in Figure 2.1.

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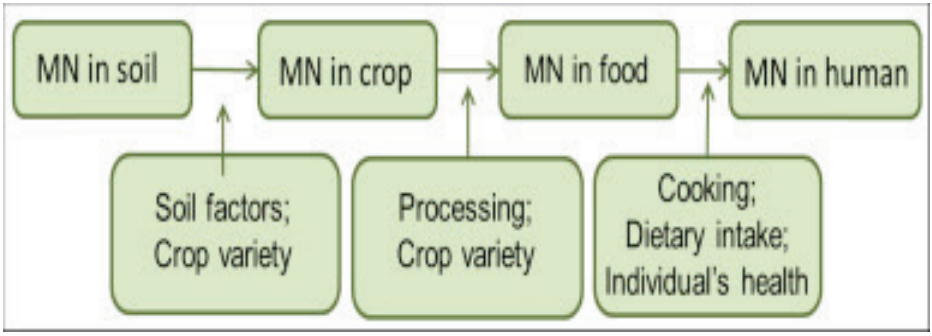

Note: MN = Micronutrients

Figure 2.1: Factors affecting bioavailability of micronutrients in crops

Table 2.1 illustrates the type and recommended amount of nutrients to be added in different biofortified crops to meet nutrient requirements as developed by Harvest Plus.

Table 2.1: Breeding targets (parts per million).

		Sweet potato	Maize	Cassava
Provitamin A	**Baseline micronutrient content**	2	0	0
	Additional content required	30	15	15
	Final target content	**32**	**15**	**15**
Iron		**Beans**	**Pearl Millet**	
	Baseline micronutrient content	50	47	
	Additional content required	44	30	
	Final target content	**94**	**77**	
Zinc		**Rice**	**Wheat**	
	Baseline micronutrient content	16	25	
	Additional content required	12	12	
	Final target content	**28**	**37**	

Source: HarvestPlus Breeding Program.

2.3 Current Status and Efforts to Address Micronutrients Deficiency through Biofortification

2.3.1 Global Situation

Biofortified crops have been released in more than 30 countries and are being tested and grown in more than 40 countries. Globally, there are 211 varieties of 11 crop types available. Currently there are 7.6 million households with 38 million beneficiaries of biofortified crops worldwide. Table 2.1 shows examples of biofortified crops developed and disseminated by HarvestPlus

Table 2.2: Examples of Harvest Plus biofortified crops

Crop	Nutrient benefits	Farmer benefits
Beans	Provides up to 80% of daily iron needs	High yielding, virus resistant, heat and drought tolerant
Maize	Provides up to 50% of daily vitamin A needs	High yielding, disease and virus resistant, drought tolerant. Reduced aflatoxin contamination
Pearl Millet	Provides up to 80% of daily iron needs	High yielding, mildew resistant, drought tolerant
Wheat	Provides up to 50% of daily zinc needs	High yielding, disease resistant
Cassava	Provides up to 100% of daily vitamin A needs	High yielding, virus resistant
Sweet potato	Provides up to 100% of daily vitamin A needs	High yielding, virus resistant, drought tolerant
Rice	Provides up to 40% of daily zinc needs	High yielding, disease and pest resistant

2.3.2 Biofortification in Tanzania

Currently, Tanzania has released nine biofortified varieties of three common staples:

i. Two (2) high iron and zinc bean varieties (Selian 14 and Selian 15) released in 2018 by Selian Agricultural Research Institute (SARI) in collaboration with the International Center of Tropical Agriculture (CIAT) under Building Nutritious Food Basket (BNFB), a project spearheaded by the International Potato Center (CIP). The biofortified varieties were recommended for production in mid to high altitude areas of Tanzania.

ii. Two (2) vitamin A maize variety (VAH 517 and VAH 519) released for commercial production by the Meru Agro Seed Company (MERUAGRO) in collaboration with the International Centre for Maize and Wheat Improvement (CIMMYT)

iii. Five (5) vitamin A orange fleshed Sweet Potato (OFSP) varieties

(Ejumula, Kiegea, Mataya, Kakamega and Kabode) released by Tanzania Agricultural Research Institute (TARI) in collaboration with CIP under several projects.

Efforts are ongoing to multiply the seeds and vines to ensure these varieties are readily available to farmers. Data on adoption and reduced malnutrition in Tanzania through these varieties are not yet established because they have been released recently. However, there has been increased availability of these varieties in local markets. Still, there is need for more knowledge and awareness creation in the communities on the importance of consuming foods made from biofortified crops and to promote growing the varieties.

Other nutrients of importance that could be considered in biofortification programs in Tanzania include micronutrients (e.g. iodine, folate, vitamin B6) and amino acids (e.g. lysine and tryptophan) for the prevention and control of stunting, underweight, wasting and other growth disorders.

2.4 Policy and Legal Framework on Biofortification

Since 2010, a variety of national public policies (including plans and strategies) and government regulations, that are likely to influence on biofortification, have been enacted.

2.4.1 National Public Policies

The relevant national public policies, plans, and strategies include:

National Agricultural Policy (2013):

In relation to biofortification, the National Agricultural Policy requires the user to abide by the biotechnology and bio-safety measures to minimize risk. The policy also emphasizes the Plant Breeders Rights Act, which protects the newly released biofortified varieties that have potential for commercialization.

Agricultural Sector Development Programme II (ASDP-II)2017/18 – 2027/2028:

The implementation of the ASDP-II is embedded with the necessary features of nutrition-sensitive agriculture, which recognizes the importance of the agricultural sector in reducing or eliminating malnutrition in Tanzania. ASDP-II emphasizes growing and using nutrient-rich crops, including those that are biofortified.

National Nutrition Strategy – July 2011/12 – June 2015/16:

This crucial document addresses food and nutrition in Tanzania. The Strategy's

clause 89 recognizes the need for multiple strategies to prevent and control nutrient deficiencies by increasing dietary intake of vitamins and minerals. It also recognizes the 2008 Copenhagen Consensus that ranked micronutrient supplementation (vitamin A and zinc) as the top solution to advance global welfare based on cost-benefit ratios, and recommended that complementary strategies within the agriculture sector should include biofortification and crop diversification.

National Multi-Sectoral Nutrition Action Plan (NMNAP) – July 2016 – June 2021:

This national action plan brings together various sectors (health, agriculture, water and sanitation, finance, social protection, etc.) to address acute malnutrition and stunting, within a wider multi-sector nutrition governance and information management system framework. The plan clearly states that scaling up prevention and control of micronutrient deficiencies is one of the seven key result areas and is ranked among the top three priority interventions. Biofortification is prioritized among other important nutrition-sensitive interventions and programs.

National Biotechnology Policy of Tanzania (2010):

This policy seeks to achieve significant investment in biotechnological tools for generation of products, processes and technologies to enhance efficiency and productivity in food and agriculture, nutrition and health, while also being cost-effective and environmentally friendly in conservation of biodiversity. The policy mission statement is to create infrastructure for research, development and commercialization in biotechnology to ensure a steady flow of bioproducts, bioprocesses and new biotechnologies for social and economic development of Tanzania.

Child Development Policy (2010):

This national policy emphasizes the need for children to get good nutrition for survival, and that access to nutritious food is a fundamental right for children. Although the policy is not specifically designed for biofortification, it provides a suitable environment for its use to improve nutrition status of children in Tanzania.

National Health Policy (2017):

The health policy for Tanzania clearly recognizes that adequate intake of nutritious food is essential for the promotion and maintenance of physical and mental health. A good nutritional status enables individuals and families to lead socially and economically productive lives. One of the emphasized actions includes promotion of availability of adequate food in quality and quantity among

vulnerable groups, specifically children and pregnant and lactating women. The policy provides a good environment for use of biofortified products.

2.4.2 Acts and Regulations

The relevant acts and regulations include:

Tanzania Food, Drugs and Cosmetics Regulation (2010):

The concern is control of food promotion regulation, which is important for ensuring that dealers (producers or sellers) of biofortified products do not make false claims.

The Seed Act (2003) and Seed regulations (2007):

All seeds produced or brought into the country are governed by the Seed Act No.18 of 2003 and Seed Regulations (2007) to ensure the seed has the required characteristics and acceptable standards. This will equally apply to biofortified crops.

CHAPTER THREE: KEY BIOFORTIFICATION GUIDES

For biofortified products to be available and used to enhance nutrition and health of individuals, programs should be in place to ensure variety development and release. This process requires a participatory approach in identifying problems to be addressed. The key players in this process include farmers, researchers, food processors and consumers. After a variety has been released, it should enter seed multiplication and distribution. Where the government and private sector cannot meet seed demand in the required quantities and time frame, selected farmers should be involved in the production of Quality Declared Seed (QDS) under supervision of an authorized body.

Farmers will be expected to use recommended Good Agricultural Practices (GAP) in production of biofortified crops as per instructions attached in labels of the seed packages and inserts. To promote utilization, awareness should be raised among stakeholders along the value chain about the nutritional value and benefits of the biofortified crop products. Marketing channels for the products should also be in place so farmers realize financial benefits. This chapter highlights key areas in the value chain and outlines the key steps towards development of biofortified food crops. Appendix III provides an illustrative diagram of the procedure for variety development and release in Tanzania.

3.1 Variety Development and Release

Variety development and release involves availing of varieties that are adapted and preferred by farmers and consumers. A participatory plant breeding approach is usually used to develop a desired variety for farmers. The reproduction system, such as self-pollination, cross-pollination or vegetative propagation of the crop will guide the choice of breeding method.

It is important to note that biofortified varieties to be developed in Tanzania should use conventional methods of breeding conducted in a natural way of reproduction or using agronomic approaches-not genetic modification.

Acquisition of the desired biofortified variety through conventional methods should start with evaluation of the germplasm materials (local or exotic) of preferred characteristics. The local and exotic materials will likely have genes for adaptation and other quality attributes, and they provide the required background of micronutrients for biofortification. After development of the adapted variety with required levels of micronutrients, the variety should be released through official channels and be included in the national variety list. Thereafter, the parent materials and breeder seeds should be maintained under official custody to retain their genetic purity.

Breeding Tips:

- Evaluate and assess local seed production and market systems
- Set a breeding goal and overall hypothesis
- Acquire breeding germplasm (i.e. local and/or exotic)
- Understand the reproductive, genetics and breeding mechanisms of target crop
- Characterize germplasm and genetic alignment to breeding goal
- Gauge resource capacity per breeding goal
- Evaluate breeding materials to see whether they meet required characteristics
- Statutory testing and variety release procedures through official channel

KEY GUIDES

i. Researchers shall abide by the relevant national policies and regulations for production of any seed variety;

ii. Research institutions shall conduct screening and evaluation of the germplasm (local and exotic) to develop varieties with quality nutritional attributes;

iii. Researchers shall conduct trials at different ecological zones for adaptability and community acceptability;

iv. Research institutions should provide guidance to extension workers and different stakeholders on production, processing and preparations of biofortified food crops;

v. Researchers shall submit new seed varieties to appropriate regulatory body for testing;

vi. The National Variety Release Committee shall approve, endorse and authorize the distribution of new seed varieties;

vii. The National Seed Committee shall register new released varieties in the National Variety List.

KEY MESSAGES

i. Biofortified varieties developed through conventional plant breeding methods **are not GMOs** and are in line with Tanzanian policies and regulations;

ii. Biofortified crop varieties provide sustainable and cost-effective means of addressing micronutrient deficiencies;

iii. Research institutions should use participatory plant breeding approaches which involve key stakeholders (farmers and consumers) in the value chain to ensure acceptability and ownership of the biofortified varieties

3.2 Seed Multiplication and Distribution

After a variety has been officially released, planting materials (seeds or vines) should be made available to farmers in sufficient quantities, affordable prices and in a reasonable time frame. Hence, both public and private sectors should be involved in production and distribution of certified seeds. The seed packets

should be labelled to show agronomic variables such as production ecologies, fertilizer requirements, spacing, production potential under optimum conditions and necessary merits for Value for Cultivation and Use (VCU).

Proper procedures for seed multiplication should be adhered to under supervision of authorized institution, which should also ensure that seeds/vines are authentic. Seed business should be conducted by qualified personnel to advise farmers correctly. Seed/vines should be packaged in various lots and sizes to suit needs of different farmers.

***Multiplication and Distribution Tips*:**

- Abide by Seed Act and Regulations
- Seed producers to multiply and distribute seeds
- Authorized institutions to supervise/oversee the production, storage, distribution and sale of seeds
- Packaging in different weight lots to meet needs of different categories of farmers
- Labelling should include colour code that identifies biofortified seeds
- Agro-dealers to provide genuine biofortified seeds with flier inserted providing instructions on how to store, plant and cultivate the seeds

KEY GUIDES

i. Researchers shall refer and abide to Acts, National Regulation and Breeders' Rights

ii. Seed multipliers shall be approved under the supervision of regulatory bodies;

iii. Seed multipliers shall avail the seeds to farmers;

iv. Seed dealers shall ensure packaging in different weight lots and use labels that contain important information about the biofortified seeds;

v. Seed dealers shall ensure provision of genuine biofortified seeds with an inserted flier providing instructions on how to store, plant and cultivate seeds;

vi. Seed business shall be conducted by qualified personnel.

KEY MESSAGES

i. Proper packaging with appropriate colour code facilitates identification and usage of biofortified seeds. Well-trained agro-dealers are key to ensuring farmers have access to quality seeds and follow good agricultural practices.

3.3 Production of Biofortified Crops

A prerequisite for production of biofortified crops is population mapping for the targeted micronutrient deficiencies. Production of biofortified crops should follow recommended GAPs and quality seeds should be obtained from registered seed dealers with properly labelled seed packages for easy identification. Crop husbandry practices for production of biofortified crops should include planting with recommended spacing to obtain optimal plant population per unit area, as well as weeding and pest control. Timely harvesting should be done after the crop reaches maturity.

***Sustainable Production Tips*:**

- Information about reliable sources of biofortified seeds should be available to farmers; and
- Information on GAPs should be accessible to biofortified crop producers

KEY GUIDES
i. Biofortified seed dealers and distributors must obtain permits from authorities responsible for quality assurance of seeds;
ii. Producers of biofortified crops shall apply Good Agricultural Practices (GAP) accordingly.
KEY MESSAGES
i. Use of genuine biofortified seeds and other recommended agro-inputs together with application of GAP enhance production and yield of biofortified crops

3.4 Post-Harvest Management

Post-harvest crop losses occur during harvest, transportation, storage, processing and consumption. These losses can be either qualitative and/or quantitative. Qualitative losses occur when the product is infected by viruses, contaminated by bacteria and fungi (including aflatoxins) or infested by insects and vermin (rats), resulting in a change of the product's shape, odour, taste and nutritional value. Quantitative losses are those resulting from reduction in physical weight. Generally, Post-Harvest Losses (PHL) might lead to food and nutrition insecurity, as well as reduced income at the household and national levels.

Although biofortified crops are rich in certain nutrients, if the crops are not handled properly, PHL may reduce the nutrient content. PHLs are more common in pro-vitamin A crops, while iron and zinc crops are more stable.

KEY GUIDES

i. Farmers should harvest food crops in a timely manner and according to technical information provided by experts and extension workers for each specific crop variety;
ii. Farmers should sort seeds before storage;
iii. Farmers and stakeholders should practice GAP on PHM of food crops;
iv. Transporters should adhere to guidelines and technical information from experts on transportation of specific biofortified crops;
v. Food traders should abide by PHM systems to prevent loss of nutrients during marketing.

KEY MESSAGES

i. To maintain intended qualities and quantities of biofortified crops, stakeholders along the value chain must adopt recommended agricultural practices and measures to mitigate Post-Harvest Loss (PHL).

3.5 Processing and Marketing of Biofortified Crops

The key issues in processing and marketing of biofortified crops are processing techniques, packaging materials, food safety and consumer acceptance. Other related issues include proper labelling, shelf life and nutrient levels. All procedures for processing and safety of biofortified foods and their related products will be regulated under the responsible regulatory body. Price determination is one of the most important factors in business and for biofortified crops, it will depend on different factors such as production costs, supply and demand. Farmers and consumers should be provided with regular market information updates. It should be noted that quality and standards are key to obtaining good markets.

KEY GUIDES

i. Food processors shall abide by the food quality standards established by respective regulatory authorities;

ii. Food processors shall abide by agro-processing and marketing policies, regulations and guidelines by seed developers in order to minimize loss of nutrients;

iii. Food processors shall use proper labels on identification of biofortified food crops and accurate instruction on how to use them;

iv. Food processors should abide to guidelines on food packaging materials as provided by food safety regulatory bodies

KEY MESSAGES

i. Processers of biofortified food products should consider that consumer acceptance depends largely on sensory characteristics, nutritional value, keeping qualities and/or shelf life;

ii. Promotion of biofortified foods is key to ensure acceptability.

3.6 Utilization of Biofortified Foods

Food utilization is one of the three dimensions of food and nutrition security. It refers to the ability of the household to use available foods to meet household members' nutritional requirements. At the individual level, food utilization refers to the ability of the human body to consume and metabolize a balanced diet in a clean and safe environment to reach a state of nutritional well-being. This involves food preparation, cooking and serving that meets the nutritional needs of different demographic groups. When preparing and cooking biofortified foods, best food preparation practices (such as cooking methods) that lead to maximum retention of nutrients and other basic hygiene measures should be applied.

KEY GUIDES

i. Institutions responsible for food safety shall ensure implementation of food safety measures and make regular inspection of food vending sites to ensure adherence to food safety procedures;

ii. Food vendors shall observe guidelines on food preparation and recipes prepared by biofortification researchers and food and nutrition experts; and use methods which will ensure maximum retention of micronutrients from biofortified products;

iii. Nutritionists/food scientists from different institutions should develop different recipes for biofortified foods to meet the nutritional needs of different demographic groups;

iv. Extension/field workers from agriculture, community development and health sectors shall promote production and consumption of biofortified foods; and

v. The MOA in collaboration with MoHCDGEC and MoE shall promote and coordinate use of biofortified foods in institutions providing mass catering such as hospitals, boarding schools, colleges; prisons, hotels, restaurants and food vendors like "Mama Ntilie".

KEY MESSAGES

i. Observing principles of hygiene and safety is necessary during preparation of biofortified foods to minimize contamination and food borne diseases;

ii. Mass feeding with biofortified foods is useful for wider population coverage to make a substantial impact on reducing micronutrient deficiencies.

3.7 Cross-Cutting Issues

Cross-cutting issues considered in this document include gender, social and behaviour change communication, climate change and people living with HIV/AIDS and tuberculosis (TB).

3.7.1 Gender Consideration

Initiatives to improve nutrition cannot be sustainable without taking into consideration the social, economic and biological differences between men and women—in particular, gender inequalities which negatively affect nutritional status of marginalized groups. Variations in gender-specific practices, including food habits and taboos, may affect a household's food production, intra-household food distribution and care of different household members. In this respect, gender issues should be considered in all biofortification initiatives.

Studies by HarvestPlus in Uganda show that women not only benefit from biofortified crops, but they also play a key role in spreading awareness about the benefits of biofortified foods (HarvestPlus Uganda, 2014).

Gender Tips:

- Gender inequalities may negatively affect production, utilization and nutrition status of marginalized groups.
- Interventions which address biofortification issues should strive for joint ownership and target increasing the bargaining power of women in decision making.

KEY GUIDES

i. Gender issues shall be mainstreamed in biofortification initiatives, policies and programs in order to reach marginalized and vulnerable groups;

ii. Promotion of production and use of biofortified crops should ensure both women and men in a household are equal owners of assets and both contribute to decision-making on resources.

KEY MESSAGES	
i.	Gender mainstreaming in biofortification initiatives is essential in scaling-up, adoption and consumption of biofortified foods.

3.7.2 Social and Behaviour Change Communication

Social and Behaviour Change Communication (SBCC) is the systematic application of interactive, theory-based and research driven communication processes and strategies for change at individual and community levels. Effectively implemented SBCC programming helps to increase knowledge and shift attitudes and cultural norms to produce desirable changes in a wide variety of behaviours including nutrition behaviours that promote the production, consumption and utilization of biofortified foods to address micronutrient deficiencies. Among the powerful tools employed by SBCC programs are mass media, community-level activities, interpersonal communication, information and communication technologies, and social media.

***SBCC Tips on Biofortification*:**

- SBCC messages and methods around biofortification should be based on data, the social context and the target audience;
- SBCC should involve mutually reinforcing communication channels to trigger change at different levels for greater impact;
- Participation and capacity building on biofortification should cut across SBCC activities to make change more sustainable;
- SBCC on biofortification should involve partners and communities throughout the process; and
- Media is an integral part of SBCC, and it should be empowered to ensure validity and credibility of biofortification communication messages sent to communities

KEY GUIDES	
i.	Political leaders, influential people and extension workers should create awareness among community members on changing behaviour towards production and consumption of biofortified food crops.
ii.	Biofortification initiatives shall incorporate SBCC strategies to support uptake and effective roll-out of interventions for production, utilization and consumption of biofortified foods; and
iii.	Awareness shall be created among political leaders to support biofortification initiatives.

KEY MESSAGES
i. SBCC messages should target beneficiaries, influencers, enablers and those involved in delivering the interventions to increase use of biofortified foods.

3.7.3 Climate Change and Environment

Change in climatic conditions brought by environmental pollution results in adverse effects on weather conditions. The effects include increased temperatures, floods and drought, which lead to the emergence of new pests such as agricultural pathogens, insects and weeds growing in areas where they did not exist before. Increased carbon dioxide concentration in the atmosphere increases photosynthetic rates and consequently carbohydrate concentration in plants, which leads to decreased concentration of macro- and micronutrients in crops. Thus, national and international efforts are needed to decrease environmental pollution and to develop biofortified varieties that have higher efficiency in absorption and translocation of the nutrients into the edible portions of crops.

Climate Change Tips:

- Climate change may reduce the levels of certain nutrients such as protein and zinc in some crops

KEY GUIDES
i. The development of biofortified crop varieties that are resilient to climate change shall be prioritized; and ii. Production of biofortified crops shall be integrated in conservation agriculture.
KEY MESSAGES
i. Development of biofortified varieties with resilience to climate change will ensure sustained production and utilization of biofortified products; ii. Many of the developed varieties are resilient to climate change.

3.7.4 Biofortification and HIV/AIDS and Tuberculosis

It is well established that HIV/AIDS and TB infections can lead to micronutrient deficiencies which may accelerate the risk of infectious diseases. The effects of an infection may lead to reduced nutrient intake and absorption.

Iron and zinc are important nutrients for people living with HIV/AIDS and TB. Therefore, the use of biofortified foods will reduce the need for prolonged use of these supplements by people living with HIV/AIDS and TB.

Tips on Micronutrients and HIV/AIDS and TB:

- There is cyclic linkage between HIV/AIDS/TB and micronutrient deficiencies
- Biofortification initiatives should be linked with interventions for addressing HIV/AIDS and TB

KEY GUIDES
i. Developers of new seed varieties should link with institutions engaged in interventions for addressing HIV/AIDS and TB before they develop new seed varieties;
ii. This guideline should be used in conjunction with the National Guidelines on Nutrition and HIV/AIDS;
iii. The consumption of biofortified foods shall be promoted for use by people living with HIV/AIDS and TB
KEY MESSAGES
i. Promote the use of iron/zinc-rich biofortified foods among people living with HIV/AIDS and TB to increase micronutrient intake.

CHAPTER 4: INSTITUTIONAL ARRANGEMENT AND DEVELOPMENT PARTNERS

The institutional framework that enables the efficient and smooth implementation of a biofortification program will involve both national and international institutions. The implementation of the biofortification initiatives will be aligned with the ASDP-II under the thematic area of the BNFP project and the NMNAP under the thematic working group on control of micronutrient deficiency and nutrition-sensitive actions.

4.1 Key Implementing Actors

The key implementing actors for the biofortification activities will be the ministries and organizations as shown in Table 4.1.**Table 4.1: Roles and responsibilities of different ministries and organizations**

A: NATIONAL LEVEL	
Ministry/Organization	**Key Roles and Responsibilities**
Ministry of Agriculture (MoA)	• Promote production and dissemination of high nutritional value crops (including biofortified crops) to ensure consumption of micronutrient-rich foods. • As a lead, MoA should ensure that development and release of biofortified varieties complies with agricultural policy, relevant acts, regulations and guidelines. • MoA, President's Office Regional Administration and Local Government (PORALG) and regional authorities should ensure efficient seed distribution, appropriate storage systems and affordable prices. • MoA, MoHCDGEC, PORALG and the media should ensure knowledge is provided to farmers on how to access biofortified seeds and share various skills on production and handling of crops. • Ensure timely availability of agro-inputs at affordable price and appropriate quantity. • MoA, Ministry of Trade and Tanzania Food and Nutrition Centre (TFNC) should ensure marketing channels for biofortified products are in place. • MoA should ensure buy-in of the biofortification initiatives by high-level policy makers. • MoA, as the lead to ministerial departments and agencies (MDA) in biofortification, should ensure dissemination of the guidelines and should create awareness on roles and responsibilities of different institutions on post-harvest management.

	• MoA, in collaboration with research institutions, should continue carrying out coordinated research programs on PHM focusing on biofortified food products. • MoA, in collaboration with other stakeholders, shall raise awareness within communities on the importance of production and consumption of biofortified variety crops.
Agricultural Research Institutes and Academia	• Conduct studies to determine nutritive value and agronomic needs of biofortified varieties. • Disseminate study findings to influence policy and practice. • Research institutions should identify and use local and/or exotic germplasm materials with preferred traits for use in breeding. • Research institutions should strengthen local breeding activities/programs for sustainable development of varieties. • Research institutions and seed official regulators should ensure authenticity of seeds that are produced and sold. • Researchers/research institutions should work closely with farmers, processors, dealers and consumers of biofortified crops and products to find solutions for identified constraints related to processing and marketing.
Agricultural Sector Consultative Group (ASCG)	• Coordinate regular stakeholder dialogue on biofortification interventions. • Provide support (financial, material and other) for biofortification interventions.
Ministry of Health	• Awareness creation and gender mainstreaming. • Supervise and monitor implementation of the micronutrient deficiency prevention and control initiative through the health sector.
Ministry of Industry and Trade	• Promote processing, packaging and distribution of biofortified products. • Enhance capacity of biofortified food actors so they meet quality standards for the domestic, regional and international markets. • Ensure that guidelines from the agricultural marketing policy are followed in marketing of biofortified foods.
Ministry of Education	• Oversee incorporation of biofortification in study curricula at schools and higher learning institutions. • Advocate for incorporation of biofortified foods into the school feeding program.
Ministry of Justice	• Supervise adherence to seed laws and regulations.
Ministry of Finance	• Ensure provision of funds for research and production of biofortified varieties and seeds.

PO-RALG	• Oversee provision of support to local government authorities on biofortified crops and adherence to standards.
Regulatory bodies	• Ensure standards and safety of biofortified products. • Technical institutions (TBS/TFDA/TFNC) should ensure that processed biofortified food products carry instructions from the manufacturer which will clearly show how the product should be prepared to attain/retain maximum nutrient content.
Development partners	• Provide international advocacy and support to biofortification programs in Tanzania.
Private sector	• Support and participate in biofortification activities including variety development, seed production and distribution, and processing.
Non-state actors	• Support on raising awareness and provide material and financial support on biofortification programs in communities.
Cooperatives	• Provide input and marketing channels for biofortified products.
Financial institutions	• Provide credits to farmers, processors and distributors of biofortified varieties and products.
B: REGIONAL LEVEL	
Regional Secretariat	The regional secretariat is responsible for providing technical support to Local Government Authorities (LGA), translating policies, guidelines, regulations and ensuring that they adhere to standards. In implementing these biofortification guidelines, the regional secretariat has the following responsibilities: • Disseminate biofortification guidelines and related legislations and ensure their use by local government authorities. • Supervise and monitor implementation of biofortification guidelines. • Provide technical support and supportive supervision to districts. • Orient district staff on the important aspects of biofortification and related health interventions. • Collect and compile biofortification intervention coverage data for developing corrective actions and for submission to national level for compilation and calculation of national coverage. • Regional and local government authorities should strengthen the capacity of their extension workers on PHM specific to biofortified crops through training.

C. DISTRICT LEVEL	
LGA	At the district level, LGAs have been mandated to supervise and implement policies, strategies and programs. In implementing these guidelines, LGAs have the following responsibilities: • Integrate biofortification interventions in Council Management Plans. • Promote and support communities to participate in the establishment and implementation of community-based biofortification interventions. • Conduct in-service training and periodic refresher updates for personnel to ensure provision of effective biofortification activities in the districts. • Provide technical supportive supervision and on-the-job mentoring of extension workers on biofortification activities at the community level. • Incorporate biofortification indicators into comprehensive council information systems. • Ensure an enabling environment for biofortification at the district level including availability of agricultural inputs and marketing channels for biofortified products. • Receive, discuss and interpret the implementation and monitoring data reports on biofortification interventions and take timely corrective measure as appropriate. • Promote and support farmers to understand and practice recommended agronomic practices for biofortified crops.
D: WARD LEVEL	
Ward Development Committees	• Plan, implement and monitor biofortification interventions at the community level.

4.2 Development Partners

Development partners—including the UN agencies, multilateral and bilateral organizations—will advocate for biofortification, and will promote and place implementation of the biofortification high on their global and national agendas. The roles of these international partners will include:

- Mobilizing the technical and financial resources for implementation, capacity development, monitoring and evaluation.
- Provide international experience, norms and standards.
- Provide evidence-based guidance and insights to adjust the biofortification strategy and promote international cooperation in the implementation.
- Support government initiatives on biofortification.

4.3 Structure for Biofortification Intervention Coordination

The proposed governance and operational structure of the biofortification program is shown in Figure 4.1. Government authorities and relevant ministries will be interlinked with public institutions, private sector, community service organizations and thematic working groups through the National Food Fortification Alliance (NFFA) that is already operating in Tanzania.

Currently, there are established crop-specific platforms on pro-vitamin A maize, high iron and zinc beans and OFSP that are co-opted members of the NFFA that was established in 2003.

A technical working group on biofortification should be established to forward issues to the NFFA. Biofortification issues will be mainstreamed in the NFFA. Various biofortification stakeholders will come together and merge with those in the NFFA to form a strong dietary improvement alliance.

Key actions

Since dietary diversification is a component of the ASDP-II, a biofortification sub-committee under the ASDP-II Steering Committee will be used to strengthen coordination, partnerships and stakeholder participation.

- The biofortification TWG will actively engage with the existing fortification alliance on modalities of having one platform.
- Collaboration among partners should ensure technology exchange rather than technology transfer.

Key messages

- Sustainability of the biofortification program is paramount and measures should be in place to facilitate this.
- Regular meetings among key stakeholders should ensure feedback mechanisms and methods of improving on current scenarios.

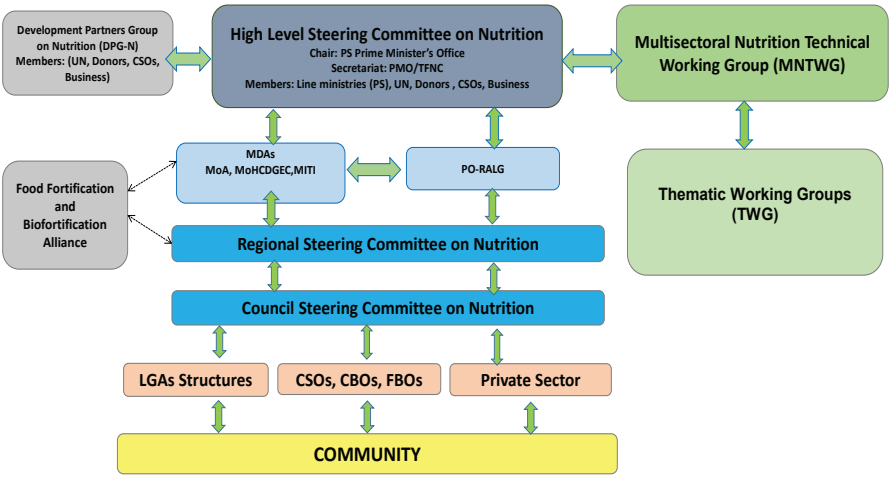

Figure: 4.1 Governance and operational structure for biofortification in Tanzania.

CHAPTER 5: MONITORING AND EVALUATION FRAMEWORK

Biofortification of staple crops is among the most important nutrition-sensitive methods for combating malnutrition as stipulated in the NMNAP for 2016-2021. However, a clear monitoring and evaluation (M&E) framework for tracking its progress has not been established, and there is no regular multi-sectoral nutrition information system in Tanzania that could help capture the contributions made by biofortification. The only nutrition-specific information systems available in the country include the five-year Tanzania Demographic and Health Surveys (TDHS) started in 1992, the four-year surveys of chronic diseases (known as STEP Surveys) started in 2009, the four-year Nutrition Public Expenditure Review (N-PER) started in 2013 and the four-year National Nutrition Surveys (NNS) started in 2014. These are evaluative in nature, given the long period between the surveys, and are therefore best used for policy and strategy development—not for tracking operational progress. Furthermore, these data systems provide information that can be analysed only at the regional and national levels while the districts/councils and communities have not been included, so it is difficult to track progress at these crucial levels.

Measuring the impact of biofortification on intended improvements in nutrition status can be challenging. The assessment entails the use of nutritional data that are not normally accessible or familiar to the agencies implementing biofortification. Thus, it is necessary to use integrated nutrition-relevant data as well as to conduct independent nutrition and health studies of specific target populations and geographic areas.

It is therefore necessary that a M&E framework is put into place to provide feedback on the biofortification implementation efforts and to measure the intended impact on issues related to malnutrition. The M&E framework will also monitor the performance on breeding the desired crop varieties, seed multiplication, and crop production and utilization. The framework (see Figure 5.1) consists of two main areas: **Implementation and Outcome Monitoring** and **Evaluation of Impact**. Quality assurance measures should be included throughout in all the steps.

5.1 Implementation and Outcome Monitoring

Implementation monitoring involves the first four key steps, starting with the extent to which awareness and/or interest in the society exists with respect to biofortification. The extent to which development partners—including government agencies—fund research projects on biofortification is reflected by the number of plant breeding research projects undertaken. Other crucial steps include release of biofortified crop varieties and distribution of the planting materials.

Monitoring at this stage involves regular data collection and aims to track input utilization, activity execution and deliverables. This level of monitoring is important to understand implementation progress and to ensure implementation fidelity among stakeholders, including researchers, farmers and consumers, as well as development partners and policymakers. Two types of indicators (process and output), as shown in Figure 5.1, are recommended. Different methods and tools can be employed in collecting data for the indicators. The methods include agricultural sample surveys involving day-to-day recording and quarterly reporting by the various implementing stakeholders such as research institutions and change agents. Different reporting forms can be designed for collecting such data.

Outcome monitoring starts with an important aspect of behaviour change, which facilitates production and utilization of biofortified crops. Therefore, outcome monitoring focuses on three aspects: behaviour change (or the extent to which biofortified crops are accepted in the society and are produced and used), farmers' adoption of GAP for biofortified crops, and the extent to which households consume biofortified food products. Several indicators can be employed in outcome monitoring as shown in Figure 5.1. Existing data collecting systems such as annual agricultural sample surveys, household budgetary surveys, dietary assessment surveys and crop forecasting can be employed to monitor the outcome of biofortification interventions.

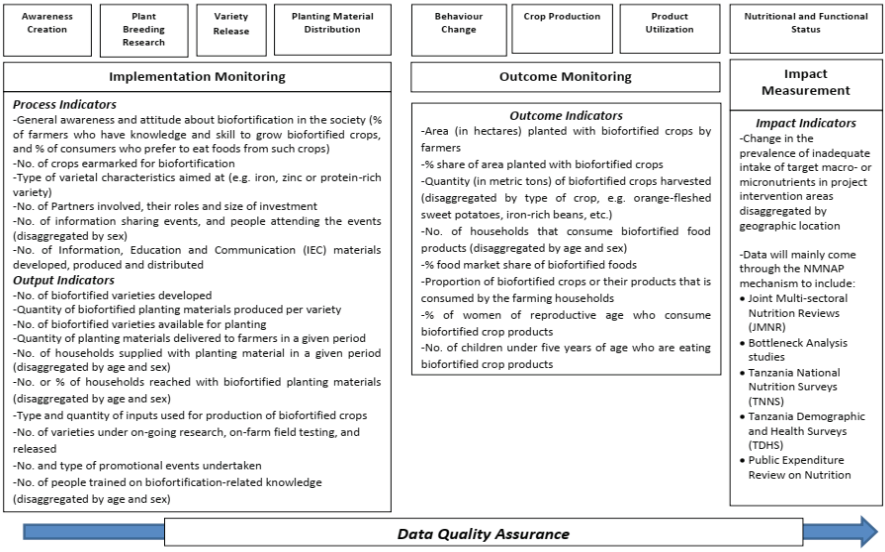

Figure 5.1: Outline of the monitoring and evaluation framework.

5.2 Evaluation of Impact

Impact measurement is a means of assessing the effectiveness of an intervention and judging the significance of changes brought about by those activities. The assessment must be tied to the intended goal of the intervention, and in this case, it is the contribution towards reduction of macro- and micronutrient deficiencies in Tanzania. The key indicator (Figure 5.1) is change in the prevalence of inadequate intake of target macro- or micronutrients in project intervention areas, disaggregated by geographic location.

However, since biofortification is part of the nutrition-sensitive interventions embedded within the NMNAP framework, much of the necessary information for evaluating its impact will also come from the Monitoring, Evaluation, Accountability and Learning (MEAL) framework of the NMNAP. Accordingly, data will be generated from the Joint Multi-sectoral Nutrition Reviews (JMNR), Bottleneck Analysis (BNA) studies, Tanzania National Nutrition Surveys (TNNS), Tanzania Demographic and Health Surveys (TDHS) and Public Expenditure Review on Nutrition.

5.3 Data Quality Assurance

To ensure the quality of data collected and used for M&E, only standard tools and methods will be employed. Such methods and tools include those used for sampling in agricultural and household surveys, as well as standard studies such as TDHS and National Nutrition Surveys. In all cases, experts from the TFNC and National Bureau of Statistics (NBS) will be consulted or involved.

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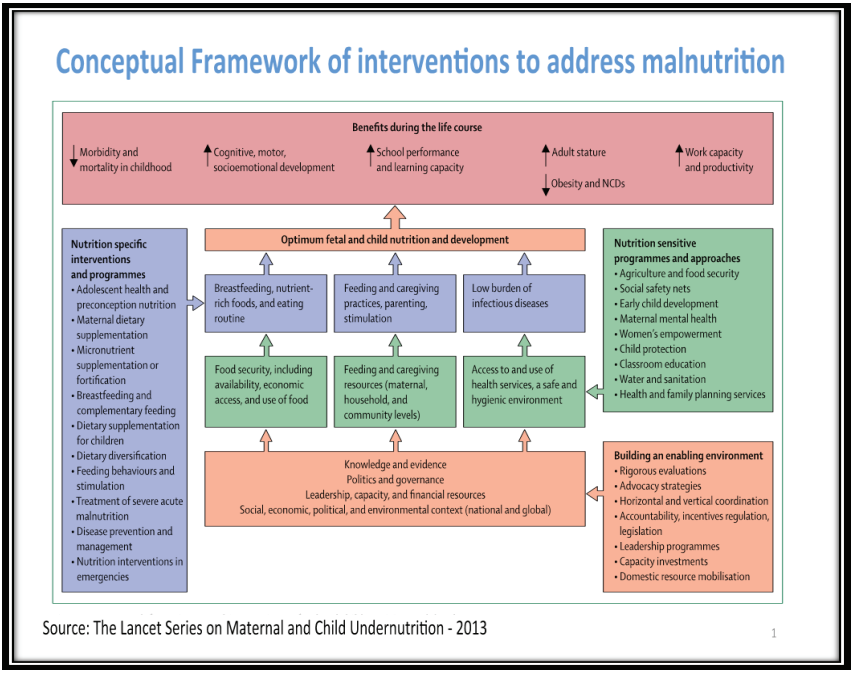
APPENDIX I: The Conceptual Framework Adopted by the NMNAP



APPENDIX II: Description of Nutrients

A. Macronutrients: Description, functions, effects of deficiency

Protein, carbohydrates and fats are macronutrients. Known as the engines of the body, macronutrients are needed in large quantities.

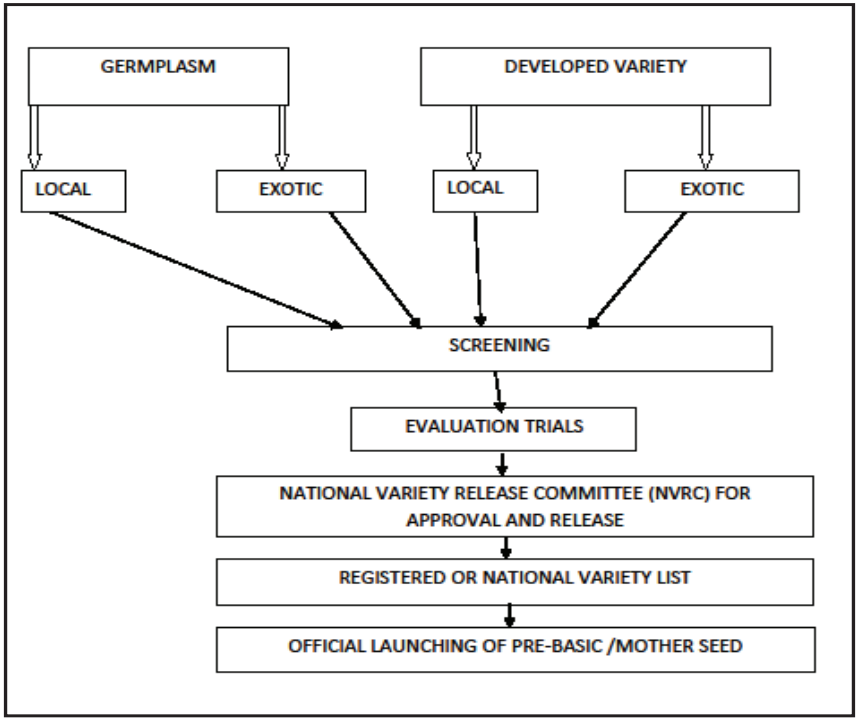
PROTEINS	CARBOHYDRATES	FATS
PROPERTIES AND FUNCTIONS		
• Build, repair and maintain body tissues • Play a role in building resistance to infection	• Primary energy source and maintain body temperature • Prevent breakdown of proteins for energy • Support metabolism of fats • Aid in growth of beneficial bacteria in colon)	• Storage of excess energy • Maintenance of body temperature • Support cell function; • Facilitates absorption, transport and utilization of vitamins A, D, E, K

FOOD SOURCES			
PLANT	Legumes (beans and peas, soya), edible algae, nuts, seeds	Cereals, maize, rice, sorghum, millet, wheat, simsim, roots and tubers (e.g. yams, potatoes, cassava, sweet potatoes), legumes, and starchy vegetables (carrots, pumpkin, green peas) *Insoluble fibre:* Whole grains, cereals, tubers and legumes, leafy vegetables and fruit with skin *Soluble fibre:* Gelatin, apples (with skin), oats, de-husked legumes, wheat bran	Oil, seeds, nuts
ANIMAL	Fish, beef, mutton, goat, pork, eggs, milk, edible insects, chicken and other edible birds (quail, guinea fowl, turkey, duck)		Butter, meat, poultry, dairy products, fish
OTHER	Breast milk for infants and young children		Margarine

B. Micronutrients: Description, functions, effects of deficiency

	VITAMIN A	IRON	ZINC
PROPERTIES AND FUNCTIONS			
	• Immunity • Activation of T-lymphocyte, • Manufacturing of white blood cells • Vision: integrity of eye and helps support night vision • Regulation of gene expression: vital to cell differentiation and physiological processes • Growth and development • Enhances metabolism of iron	• Immunity • Manufacturing of red blood cells • Transporting oxygen in the body • Supports normal growth of body tissues and brain tissues, in particular • Educability • Work performance	• Immunity • Antioxidant • Anti-inflammatory • Co-factor of other vitamins • Growth and development especially reproductive system • Skin and hair maintenance
FOOD SOURCES			
	Fat soluble, so requires presence of some fat in food to facilitate absorption.	Absorption of both inhibited by phytates and polyphenols, and enhanced by vitamin C, animal foods, fermentation.	
PLANT	Occurs as provitamin carotenoids e.g. beta-carotene in: • Yellow and orange fruits, (e.g. papaya, mango) • Dark green vegetables • Red palm oil • Biofortified cereals (e.g. maize) • Tubers (e.g. OFSP)	Occurs as non-haem iron in legumes, grains, green vegetables	Peanuts, seeds, legumes
ANIMAL	Occurs as retinol or retinyl esters in meat, liver, cod liver fish oil, milk, egg yolks	Occurs as haem iron in red meat, liver, cod liver fish oil, milk, egg yolks	Liver, meat, eggs, fish, shellfish.

APPENDIX III: DEVELOPMENT AND RELEASE PROCEDURES OF IMPROVED VARIETIES (INCLUDING BIOFORTIFIED)



APPENDIX IV: Taskforce Team for the Development of the Biofortification Guidelines

A: Core Task Force Members and Responsibilities

Institution	Full name	Responsibility
Ministry of Agriculture: National Food Security Department	Ms. Margaret Natai **(Team leader)**	Agriculture related nutrition issues
	Mr. Ben Gration	Postharvest management, processing, quality and safety issues
Directorate of Policy and Planning	Mr. Ally Mnzava	Ensure the guideline is in line with government documents and policy issues
Crop Development Department	Ms. Victoria Ngowi	Issues related to crop production and GAPs
Directorate of Policy and Planning Economist	Dr. B. Hango	Ensure the guideline is in line with government documents and policy issues
Ministry of Health Community Development Gender Elderly and Children	Ms. Julitha Masanja	Responsible for ensuring gender issues are incorporated
Tanzania Food and Nutrition Centre	Dr. Eliphato Towo **(Co-team Leader)**	Food and nutrition issues Food technology and analysis
Tanzania Food and Nutrition Centre	Dr. Kasankala	Researcher (OFSP)
Tanzania Agriculture Research Institute (TARI)	Dr. Domina Ester Nkuba Dr. Mshongi -Ilonga Dr. Richard Kasuga	Head Post-Harvest Technology Unit (OFSP Researcher) Researcher (Maize) Researcher with experience on biofortification in Tanzania
Ministry Industry Trade and Investment (MITI)	Mr. Festo Kapelo	Input on trade and marketing issues
Tanzania Official Seed Certification Institute (TOSCI)	Mr. Salehe Waziri	Issues related to crop varieties and seed certification
Agriculture Seed Agency (ASA)	Ms. Jacqueline Shayo	Ensure seed policies are adhered to
Tanzania Food and Drug Authority (TFDA)	Ms. Zubeda Magero	Ensure quality and standard issues are incorporated in the guideline
Tanzania Bureau of Standards (TBS)	Ms. Stephanie Kaaya	Issues related to standards

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