PAS 233:2021

Zinc enriched wheat, maize and rice grain – Specification

HarvestPlus

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Global Alliance for Improved Nutrition

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Foreword

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Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

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0 Introduction

0.1 General

HarvestPlus leads and coordinates a global effort within the Consultative Group on International Agricultural Research (CGIAR) network to improve nutrition by promoting biofortified staple crops. This effort focuses on catalyzing the development, production, delivery and consumption of foods that are rich in essential micronutrients, including vitamin A, iron and zinc. In May 2018, HarvestPlus and GAIN launched a landmark partnership to accelerate progress towards improving access to biofortified seed, grain and foods via commercial channels with the Commercialisation of Biofortified Crops (CBC) programme.

0.2 Zinc

This PAS will focus on crops enriched with zinc through biofortification (breeding or agronomic) technology. Billions of people around the world are at risk of zinc deficiency. Zinc is an essential micronutrient that is important for several functions in the body, including:

a) growth and development;
b) immune system function;
c) reproductive health; and
d) healthy body tissues.

When consumed daily, zinc enriched maize, rice and wheat could contribute 35% to 80% of daily zinc needs for women and young children.

NOTE 1 *See HarvestPlus publication,* Estimated Average Requirements Provided by Biofortification *[1].*

Several factors determine the amount of zinc absorbed by the body from zinc enriched crops, such as average daily consumption, degree of processing and form of final food product, and bioavailability of the zinc. Research has shown that zinc absorption from zinc enriched foods is higher than that from conventional crops.

NOTE 2 *See* Bioavailability of iron, zinc, and provitamin A carotenoids in biofortified staple crops *[2] and* Food Biofortification – Reaping the Benefits of Science to Overcome Hidden Hunger – A paper in the series on The Need for Agricultural Innovation to Sustainably Feed the World by 2050 *[3].*

Furthermore, regular consumption of zinc enriched crops has been shown to improve health, e.g. by reducing illness among children, with additional research ongoing.

NOTE 3 Food Biofortification – Reaping the Benefits of Science to Overcome Hidden Hunger – A paper in the series on The Need for Agricultural Innovation to Sustainably Feed the World by 2050 *[3] and* Efficacy of high zinc biofortified wheat in improvement of micronutrient status, and prevention of morbidity among preschool children and women – a double masked, randomized, controlled trial *[4].*

0.3 Rationale

Zinc enriched grains are visually indistinguishable from standard commercial grains. To facilitate domestic, regional, and international procurement and trade of zinc enriched maize, rice and wheat, individuals and entities along the value chain need to have specific guidance in order to differentiate the zinc content of zinc enriched grains. The requirements outlined in this PAS identify global standards for zinc enriched crops and aid in widespread adoption and scale-up of these commodities in local and global food systems.

The methods and definitions of the biofortification technology used to create more nutritious crops are set out in several other regulatory and academic publications. Zinc enriched maize, rice and wheat are the terms used throughout this PAS to define the final grain product. All terms associated with biofortification (i.e. biofortified, biofortify) are not used within this PAS but are accepted terms for identifying nutrient enriched grains. These terms might be used by various entities, including, but not limited to, international nutrition and agriculture agencies, governments, researchers, and private and public enterprises. It is important to note that consumer understanding and acceptance of the term "biofortification" might vary country to country.

PAS 233 is not intended to be a position statement on the different types of breeding technologies available to produce zinc enriched maize, rice or wheat. This PAS focuses on the zinc concentration in the final grain product and its impact on human nutrition, not on the technology used. The PAS sponsor and steering committee members acknowledge the ongoing international conversation concerning the use and acceptance of conventional and transgenic crops among global stakeholders and consumers. It is the responsibility of the user of this PAS to abide by current regulations within countries and to properly communicate to consumers, as applicable, the source of the grain and the breeding technology used.

At the time of publication, conventional plant breeding was the most widely available and adopted form of zinc enriched maize, rice and wheat, and there is a robust collection of scientific literature on the subject published in peer-reviewed journals. Other technologies to enhance zinc concentration or bioavailability in crops for human health are currently in development and will be tested and evaluated as these crops become available.

1 Scope

This PAS specifies requirements for zinc enriched maize (*Zea mays),* rice *(Oryza sativa)* and wheat *(Triticum aestivum)* intended as food for human consumption. It includes requirements for:

a) class levels of zinc concentration;

b) sampling guidance;

c) packaging; and

d) labelling.

This PAS is applicable only to zinc enriched grain produced from seed developed using breeding technologies or agronomic practices such as fertilization.

NOTE 1 *The breeding methods permitted by a country for local production and/or import or export markets are regulated by national and international legislation and are outside the scope of this PAS.*

This PAS is not applicable to grain that has undergone post-harvest fortification.

This PAS is intended for all entities, regardless of size, that are producing, procuring, and selling zinc enriched maize, rice and wheat grain for human consumption.

This PAS is intended to be used by private and public enterprises in sectors of the food supply chain that procure and sell grain, governments, and associated quality and compliance agencies.

NOTE 2 *Examples of users of this PAS include, but are not limited to, food aid organizations, aggregators, traders, millers, primary food processors, seed producers, food manufacturers, national agriculture agencies and food standards agencies.*

This PAS does not cover standards for all quality characteristics, contaminants (e.g. heavy metals, pesticide residues, mycotoxins and noxious seeds) or nutrient claims for food labelling.

NOTE 3 *Standards and regulations for these components are described elsewhere in Codex Alimentarius [5] and by regional or national authorities.*

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies[1)]. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN ISO 712, *Cereals and cereal products – Determination of moisture content (Basic reference method)*

BS EN ISO 24333, *Cereals and cereal products – Sampling*

[N1] AOAC INTERNATIONAL. *Lead, Cadmium, Zinc, Copper and iron in foods. AOAC 999.10. 2005*

[1)] Documents that are referred to solely in an informative manner are listed in the Bibliography.

3 Terms and definitions

For the purposes of this PAS, the following terms and definitions apply.

3.1 biofortification

process of increasing the nutrition quality of food crops through conventional plant breeding, improved agronomic practices and/or modern biotechnologies

3.2 brown rice

paddy rice where only the husk has been removed

NOTE *Includes de-husked rice.*

3.3 commercially milled rice

degree of milling ranging from 8% to 12%

3.4 global baseline

average level of zinc concentration found in a commercial crop

NOTE *For the purposes of this PAS, a conservative global baseline of 25 ppm (2.5 mg/100 g) for maize and wheat and 16 ppm (1.6 mg/100 g) for rice is used; see* Progress Update: Crop Development of Biofortified Staple Food Crops Under HarvestPlus *[6].*

3.5 nutrient enriched crops

staple crops containing increased levels of specific micronutrients as a result of plant breeding or agronomic practices

3.6 paddy (rough) rice

rice that has retained its husk after threshing

3.7 polished

rice in which all or part of the brand and germ has been removed from brown rice through the milling process

NOTE *Includes milled or white rice.*

3.8 zinc enriched

increased levels of zinc above a specified baseline as a result of conventional plant breeding or agronomic practices

4 Maize

COMMENTARY ON CLAUSE 4

This PAS refers to shelled whole maize grain.

4.1 Quality requirements

4.1.1 Zinc enriched maize shall be safe and suitable for human consumption.

4.1.2 Zinc enriched maize shall be free from abnormal flavours, foreign odours, mould and living insects.

4.1.3 Zinc enriched maize shall be dried and stored at a moisture content not exceeding 14%, in accordance with BS EN ISO 712.

NOTE *Different moisture content might be required depending on climate and storage conditions.*

4.2 Zinc concentration requirements

4.2.1 Classification of zinc enriched maize shall be based on zinc concentration limits in accordance with Table 1.

NOTE *Class I provides the highest nutrition impact when consumed as a whole grain minimally processed food. Zinc enriched maize should be produced under optimal agricultural conditions and agronomic practices to achieve the highest zinc content.*

Table 1 – Levels of zinc concentration in zinc enriched maize grain

Class	Zinc concentration mg/kg	Standard method of analysis (or equivalent)
Class I	≥37	AOAC 999.10 [N1]
Class II	34.0 – <37	
Class III	31.0 – <34	

4.2.2 Zinc enriched maize shall be safely handled and properly cleaned to prevent mineral contamination (from soil and equipment) during analysis.

NOTE *Contamination might cause an elevated reading of zinc during analysis and result in an inaccurate assessment of the zinc content of zinc enriched maize.*

4.2.3 Zinc enriched maize shall be analysed using precision analytical methods [e.g. inductively coupled plasma atomic emission spectroscopy (ICF-OES), X-ray fluorescence (XRF)] in a certified laboratory with established quality control measures able to quantify its level of error to obtain accurate and reliable information of the zinc concentration of the crop and indicators of contamination (i.e. measurement of other select minerals, such as aluminum, chromium or titanium).

NOTE *Laboratories providing or intending to provide a zinc concentration test should demonstrate levels of competence, such as partaking in a proficiency testing programme and quality assurance (e.g. BS EN ISO/IEC 17025 accreditation) for zinc enriched maize, rice and/or wheat.*

4.2.4 The incremental zinc increase shall be calculated against the global baseline zinc value of 25 mg/kg (2.5 mg/100 g) for commercial maize varieties.

NOTE 1 *See Annex A for more information on baselines and establishing target zinc concentration levels.*

NOTE 2 *Zinc concentration levels are established based on food consumption for target populations (children 4–6 years old and non-pregnant, non-lactating women of reproductive age), estimated nutrient losses during processing and nutrient bioavailability [6].*

4.3 Sampling

Representative sampling shall be carried out in accordance with the methods specified in BS EN ISO 24333.

NOTE *See Annex B for further guidance on appropriate amounts to sample based on lot size.*

4.4 Packaging

4.4.1 Zinc enriched maize shall be stored in clean, clearly labelled and intact sacks. Sacks shall be securely closed and sealed during transport and storage to protect from water, pests and micro-organisms.

4.4.2 Zinc enriched maize shall be packed in containers to safeguard the hygienic, nutritional, technical and organoleptic qualities of the product.

4.4.3 Containers shall be made of substances that are safe and suitable for the storage of grain for human consumption.

4.5 Labelling

4.5.1 In addition to the requirements of local food and grain labelling standards, each package shall be legibly labelled with the following information:

a) product name identified as "zinc enriched maize grain";
b) zinc class (I, II or III);
c) location of production;
d) batch or lot number;
e) date of harvest;
f) net weight (kg); and
g) name and address of manufacturer or packer.

4.5.2 Information for non-retail containers shall be given either on the container or in accompanying documents, except that the name of the product, lot identification, and the name and address of the manufacturer or packer shall appear on the container.

NOTE *Lot identification and the name and address of the manufacturer or packer may be replaced by an identification mark provided that such a mark is clearly identifiable with the accompanying documents.*

5 Rice

*COMMENTARY ON CLAUSE **5***

This PAS applies to brown rice or commercially milled rice.

5.1 Quality requirements

5.1.1 Zinc enriched rice shall be safe and suitable for human consumption.

5.1.2 Zinc enriched rice shall be free from abnormal flavours, foreign odours, mould and living insects.

5.1.3 Zinc enriched rice shall be dried and stored at a moisture content not exceeding 14%, in accordance with BS EN ISO 712.

***NOTE** Different moisture content might be required depending on climate and storage conditions.*

5.2 Rice classification

5.2.1 Zinc enriched rice shall be sorted based on kernel size as long, medium or short grain, as described in CXS 198-1995 [5].

5.2.2 Zinc enriched rice shall be sorted based on degree of milling, as applicable.

***NOTE** It is recommended that zinc enriched rice be polished to a degree of milling 8%–12% or less. Over milling rice removes a significant amount of zinc, thus reducing the nutrition benefit.*

5.3 Sampling

Representative sampling shall be carried out in accordance with the methods specified in BS EN ISO 24333.

***NOTE** See Annex B for further guidance on appropriate amounts to sample based on lot size.*

5.4 Zinc concentration requirements

5.4.1 Zinc enriched rice shall be classified based on zinc content limits in accordance with Table 2 or Table 3.

Table 2 – Levels of zinc concentration in zinc enriched husked brown rice

Class	Zinc concentration mg/kg	Standard method of analysis (or equivalent)
Class I	≥ 36	AOAC 999.10 [N1]
Class II	33.0 – <36	
Class III	30.0 – <33	

Table 3 – Levels of zinc concentration in zinc enriched milled rice

Class	Zinc concentration mg/kg	Standard method of analysis (or equivalent)
Class I	≥ 28	AOAC 999.10 [N1]
Class II	25.0 – <28	
Class III	22.0 – <25	

***NOTE** Class I provides the highest nutrition impact when consumed as a whole grain minimally processed food. Zinc enriched rice should be produced using optimal agricultural conditions and agronomic practices to achieve the highest zinc content.*

5.4.2 Zinc enriched rice shall be safely handled and properly cleaned to prevent mineral contamination (from soil and equipment) during analysis.

***NOTE 1** Contamination might cause an elevated reading of zinc during analysis and result in an inaccurate assessment of the zinc content of zinc enriched rice.*

***NOTE 2** Paddy (rough) rice has a high level of soil contamination and therefore should not be used to determine the zinc content of zinc enriched rice.*

5.4.3 Zinc enriched rice shall be analysed using precision analytical methods [e.g. inductively coupled plasma atomic emission spectroscopy (ICF-OES), X-ray fluorescence (XRF)] in a certified laboratory with established quality control measures able to quantify its level of error to obtain accurate and reliable information on the zinc concentration of the crop and indicators of contamination (i.e. measurement of other select minerals, such as aluminum, chromium or titanium).

NOTE *Laboratories providing or intending to provide a zinc concentration test should demonstrate levels of competence such as partaking in a proficiency testing programme and quality assurance (e.g. BS EN ISO/IEC 17025 accreditation) for zinc enriched maize, rice and/or wheat.*

5.4.4 The incremental zinc increase shall be calculated against the global baseline zinc value of 24 mg/kg (2.4 mg/100 g) for commercial de-husked brown rice.

NOTE *See Annex A for more information on baselines and establishing target zinc concentration levels.*

5.4.5 The incremental zinc increase shall be calculated against the global baseline zinc value of 16 mg/kg (1.6 mg/100 g) for commercial milled rice with degree of polishing approximately 8%–12%.

NOTE *Zinc concentration levels are established based on physiological requirements and food consumption for target populations (children 4–6 years old and non-pregnant, non-lactating women of reproductive age), estimated nutrient losses during processing and storage, and nutrient bioavailability [7].*

5.5 Packaging

5.5.1 Zinc enriched rice shall be stored in clean, clearly labelled and intact sacks. Sacks shall be securely closed and sealed during transport and storage to protect from water, pests and micro-organisms.

5.5.2 Zinc enriched rice shall be packed in containers to safeguard the hygienic, nutritional, technical and organoleptic qualities of the product.

5.5.3 Containers shall be made of substances that are safe and suitable for the storage of grain for human consumption.

5.6 Labelling

5.6.1 In addition to the requirements of local and international food and grain labelling standards, each package shall be legibly labelled with the following information:

a) product name identified as “zinc enriched rice grain”;
b) zinc class (I, II or III);
c) location of production;
d) batch or lot number;
e) date of harvest;
f) net weight (kg); and
g) name and address of manufacturer or packer.

5.6.2 Information for non-retail containers shall be given either on the container or in accompanying documents, except that the name of the product, lot identification, and the name and address of the manufacturer or packer shall appear on the container.

NOTE *Lot identification and the name and address of the manufacturer or packer may be replaced by an identification mark provided that such a mark is clearly identifiable with the accompanying documents.*

6 Wheat

*COMMENTARY ON CLAUSE **6***

This PAS applies to threshed whole wheat grain.

6.1 Quality requirements

6.1.1 Zinc enriched wheat shall be safe and suitable for human consumption.

6.1.2 Zinc enriched wheat shall be free from abnormal flavours, foreign odours, mould and living insects.

6.1.3 Zinc enriched wheat shall be dried and stored at a moisture content not exceeding 14%, in accordance with BS EN ISO 712.

***NOTE** Different moisture content might be required depending on climate and storage conditions.*

6.2 Zinc content requirements

6.2.1 Zinc enriched wheat shall be classified based on zinc content limits in accordance with Table 4.

***NOTE** Class I provides the highest nutrition impact when consumed as a whole grain minimally processed food. Zinc enriched wheat should be produced using optimal agricultural conditions and agronomic practices to achieve the highest zinc content.*

Table 4 – Levels of zinc concentration in zinc enriched milled wheat

Class	Zinc concentration mg/kg	Standard method of analysis (or equivalent)
Class I	≥ 37	AOAC 999.10 [N1]
Class II	34.0 – <37	
Class III	31.0 – <34	

6.2.2 Zinc enriched wheat shall be safely handled and properly cleaned to prevent mineral contamination (from soil and equipment) during analysis.

***NOTE** Contamination might cause an elevated reading of zinc during analysis and result in an inaccurate assessment of the zinc content of zinc enriched wheat.*

6.2.3 Zinc enriched wheat shall be analysed using precision analytical methods [e.g inductively coupled plasma atomic emission spectroscopy (ICF-OES), X-ray fluorescence (XRF)] in a certified laboratory with established quality control measures able to quantify its level of error to obtain accurate and reliable information of the zinc concentration of the crop and indicators of contamination (i.e. measurement of other select minerals, such as aluminum, chromium or titanium).

***NOTE** Laboratories providing or intending to provide a zinc concentration test should demonstrate levels of competence, such as partaking in a proficiency testing programme and quality assurance (e.g. BS EN ISO/IEC 17025 accreditation) for zinc enriched maize, rice and/or wheat.*

6.2.4 The incremental zinc increase shall be calculated against the estimated global baseline zinc value of 25 mg/kg (2.5 mg/100 g) for commercial wheat varieties.

***NOTE 1** See Annex A for more information on baselines and establishing target zinc concentration levels.*

***NOTE 2** Zinc concentration levels are established based on food consumption for target populations (children 4–6 years old and non-pregnant, non-lactating women of reproductive age), estimated nutrient losses during processing and nutrient bioavailability [7].*

6.3 Sampling

Representative sampling shall be carried out in accordance with the methods specified in BS EN ISO 24333.

***NOTE** See Annex B for further guidance on appropriate amounts to sample based on lot size.*

6.4 Packaging

6.4.1 Zinc enriched wheat shall be stored in clean, clearly labelled and intact sacks. Sacks shall be securely closed and sealed during transport and storage to protect from water, pests and micro-organisms.

6.4.2 Zinc enriched wheat shall be packed in containers to safeguard the hygienic, nutritional and organoleptic qualities of the product.

6.4.3 Containers shall be made of substances that are safe and suitable for the storage of grain for human consumption.

6.5 Labelling

6.5.1 In addition to the requirements of the local and international food and grain labelling standards, each package shall be legibly labelled with the following information:

a) product name identified as "zinc enriched wheat grain";
b) zinc class (I, II or III);
c) location of production;
d) batch or lot number;
e) date of harvest;
f) net weight (kg); and
g) name and address of manufacturer or packer.

6.5.2 Information for non-retail containers shall be given either on the container or in accompanying documents, except that the name of the product, lot identification, and the name and address of the manufacturer or packer shall appear on the container.

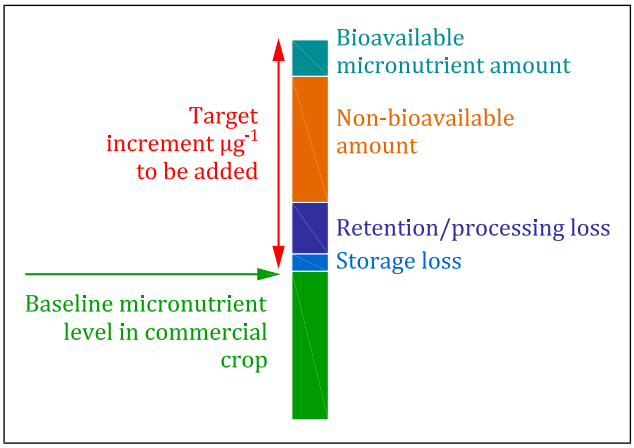
NOTE *Lot identification and the name and address of the manufacturer or packer may be replaced by an identification mark provided that such a mark is clearly identifiable with the accompanying documents.*

Annex A (informative)
Nutrient enriched crops and establishing target zinc concentration values

During the development phase for biofortification, the nutrition target increment for zinc was established at +12 mg/kg (1.2 mg/100 g) above the standard global baseline zinc content of existing market varieties for wheat, rice and maize. This target was established based on average consumption, losses during storage and processing, and bioavailable amount of the micronutrient (see Table A.1).

Research on the zinc bioavailability, retention, and processing losses of zinc enriched maize, rice and wheat has been conducted by HarvestPlus and several other partners and is ongoing and publicly available in peer-reviewed academic journals.

Figure A.1 – Establishing target increments



The baseline, or average content of a micronutrient, such as zinc and several other trace elements, might vary country to country and even within a large country due to different agroecological zones. These natural variations occur and are based on factors external to the plant, including soil health, plant maturation, climate conditions, water availability, and several other environmental and biological elements. Select germplasms might also have naturally higher levels. Due to these variations, a global baseline value is established to set uniform standards to assist breeding programmes, governments, and industries implement and scale biofortification.

Before a zinc enriched crop is released by a government and made available to farmers, the crop undergoes field testing in the local growing conditions to verify that the agronomic traits and final micronutrient content (baseline + target incremental increase) are acceptable. These field trials follow guidelines and protocols that are standard practice among researchers, plant breeders and the national agricultural research system (NARS).

Additional protocols and guidelines for micronutrient analysis of nutrient enriched crops have been published in several academic journals and are publicly available.

***NOTE** See the HarvestPlus Biofortified Crops Around the World map [8] to see where zinc enriched crops are currently released or in testing or contact the national agricultural authorities in the country of interest.*

As increased zinc content becomes mainstreamed into breeding programmes, the baseline value of a crop continues to evolve over time. HarvestPlus and other global leaders in biofortification continue to evaluate and update regional and global baseline data as it becomes available.

Table A.1 – Global baseline values and target increment for zinc enriched crops

Crop	Global baseline	Target increment mg/kg	Class I	Class II	Class III
Zinc maize	25 mg/kg	+12 mg/kg	≥12 mg/kg above baseline	9.0 – <12 mg/kg above baseline	6.0 – <9 mg/kg above baseline
Zinc rice	16 mg/kg	+12 mg/kg	≥12 mg/kg above baseline	9.0 – <12 mg/kg above baseline	6.0 – <9 mg/kg above baseline
Zinc wheat	25 mg/kg	+12 mg/kg	≥12 mg/kg above baseline	9.0 – <12 mg/kg above baseline	6.0 – <9 mg/kg above baseline

EXAMPLE
A company in India wants to procure zinc enriched wheat variety Zn123. A sample of the crop is sent to a certified reference laboratory for analysis and the zinc enriched crop has 40 mg/kg zinc content. The baseline value of zinc in wheat from India is 25 mg/kg. Variety Zn123 is 15 mg/kg above the baseline and therefore qualifies as a Class I product.

Annex B (informative) Sampling requirements

Obtaining a representative grain sample is essential for accurate analyses. Representative samples can be collected using established standards for international sampling methods (see BS EN ISO 24333). The minimum representative sample size for laboratory analysis of nutrient enriched crops is between 1 kg and 2 kg.

It is recommended that representative sampling be done using a hand probe. The number of probes taken per bag depends on the total number of bags in the lot and the size of the hand probe. If more grain is collected than is required for analysis (e.g. 3 kg), take a subsample to obtain the minimum amount required for laboratory analysis.

a) For lots or sub-lots < 1 metric tonne (MT), randomly collect samples from at least six bags (packed in a 50 kg bag).
b) For lots or sub-lots 1–3 MT, randomly collect samples from 30% of the bags (packed in a 50 kg bag).
c) For lots or sub-lots 3–20 MT, randomly collect samples from 10% of the bags (packed in a 50 kg bag).
d) For lots or sub-lots > 20 MT, randomly collect samples from 3% of the bags (packed in a 50 kg bag).

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

Other publications

[1] HARVESTPLUS. *Estimated Average Requirements Provided by Biofortification*. 2020 https://www.harvestplus.org/content/estimated-average-requirements-provided-biofortification

[2] LA FRANO, M. R., F. F. De MOURA, E. BOY, B. LONNERDAL, and B. J. BURRI. 2014. *Bioavailability of iron, zinc, and provitamin A carotenoids in biofortified staple crops*. Nutr Rev 2:289–307.

[3] COUNCIL FOR AGRICULTRUAL SCIENCE AND TECHNOLOGY (CAST) 2020. *Food Biofortification – Reaping the Benefits of Science to Overcome Hidden Hunger – A paper in the series on The Need for Agricultural Innovation to Sustainably Feed the World by 2050*. Issue Paper 69. CAST, Ames, Iowa.

[4] SAZAWAL, S., U., DHINGRA, P., DHINGRA, A., DUTTA, S., DEB, J., KUMAR, P., DEVI, and A. PRAKA. *Efficacy of high zinc biofortified wheat in improvement of micronutrient status, and prevention of morbidity among preschool children and women - a double masked, randomized, controlled trial*. 2018. Nutr J 17:86.

[5] CODEX ALIMENTARIUS. CODEX Standard for Rice 198.

[6] ANDERSSON, M.S., SALTZMAN, A, VIRK P.S., PFEIFFER, W.H. *Progress Update: Crop Development of Biofortified Staple Food Crops Under HarvestPlus*. African Journal of Food, Agriculture, Nutrition and Development Vol. 15, No. 2, April 2017.

[7] HOTZ, C.C., McCLAFFERTY, B. *From harvest to health: Challenges for developing biofortified staple foods and determining their impact on micronutrient status*. Food Nutrition Bulletin 28: Section 271–279, 2007.

[8] HARVESTPLUS. *HarvestPlus Biofortified Crops Around the World map*. https://www.harvestplus.org/content/biofortified-crop-map-what-available-where

Further reading

BS ISO 7970, *Wheat (Triticum aestivum L.) – Specification*

BS ISO 7301, *Rice – Specification*

BS ISO 19942, *Maize (Zea mays L.) – Specification*

CODEX ALIMENTARIUS. CODEX Standard for Wheat and Durum Wheat. 199–1995.

CODEX ALIMENTARIUS. *CODEX Standard for Maize (Corn).* 153–1985.

EAST AFRICAN STANDARD. *EAS 2:2011, Maize grains – Specification*

EAST AFRICAN STANDARD. *EAS 128:2011, Milled rice – Specification*

EAST AFRICAN STANDARD. *EAS 51:2011, Wheat grains – Specification*

Agricultural Engineering Unit International Rice Research Institute (IRRI) AGRICULTRUAL ENGINEERING UNIT INTERNATIONAL RICE RESEARCH INSTITUTE. *Rice Milling Teaching Manual*.

http://www.knowledgebank.irri.org/ericeproduction/PDF_&_Docs/Teaching_Manual_Rice_Milling.pdf

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