LFSP Technical Brief on Orange Maize Grading Standards in Zimbabwe

Zimbabwe Government
HarvestPlus Better Crops • Better Nutrition
IAPRI Indaba Agricultural Policy Research Institute
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About LFSP: The Zimbabwe Livelihoods and Food Security Programme (LFSP), Agriculture Productivity and Nutrition Component (APN) is managed by the Food and Agriculture Organisation of the United Nations (FAO), with the aim of contribute to poverty reduction through increased incomes for a target 250,000 smallholder farming households. The programme is being implemented in four provinces covering 12 districts as follows: Mutasa, Mutare, and Makoni in Manicaland; Guruve, Bindura, Mazowe and Mt Darwin in Mashonaland Central; Kwekwe, Gokwe North, Gokwe South and Shurugwi in Midlands and Zvimba in Mashonaland West provinces. FAO is in partnership with three NGO consortia led by Practical Action, Welthungerhilfe and World Vision International, two Strategic Technical partners i.e. IAPRI for policy influence, HarvestPlus for biofortification, three Commercial Banks, 1 Wholesale Facility - the Zimbabwe Microfinance Fund (ZMF), 5 Microfinance Institutions (MFIs) and the USAID managed DCA Facility. To date the LFSP is funded for two phases to the tune of £72.4m.

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Any views expressed or remaining errors are solely the responsibility of the authors.

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Acronyms

AGRITEX	Department of Agricultural, Technical and Extension Services
CFU	Commercial Farmers' Union
CIAT	International Centre for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
DR&SS	Department of Research and Specialist Services
GMB	Grain Marketing Board
IAPRI	Indaba Agricultural Policy Research Institute
MLAFWRR	Ministry of Lands, Agriculture, Fisheries, Water and Rural Resettlement
TOR	Terms of Reference
ZCFU	Zimbabwe Commercial Farmers' Union
ZFU	Zimbabwe Farmers' Union
ZNFU	Zimbabwe National Farmers' Union

1. Introduction

The Government of Zimbabwe through the Department of Research and Specialist Services (DR&SS) with support from HarvestPlus through the International Maize and Wheat Improvement Centre (CIMMYT), have on an ongoing basis been breeding, testing, and releasing varieties of biofortified vitamin A maize (orange maize). As a result, Zimbabwe has successfully introduced orange maize on a commercial basis. The orange maize contains pro vitamin A carotenoids, which are converted by the body into vitamin A. Vitamin A is necessary for growth and development – especially in children, maintenance of a healthy immune system, normal vision, healthy skin and organs like the gut, heart, lungs and kidney in addition to a healthy reproductive system.

The introduction of orange maize is part of governments multiple strategies for reducing the prevalence of vitamin deficiency in the country, the other two being supplementation, whereby all children under five years of age receive vitamin A drops and the compulsory fortification of cooking oil, sugar, flour and maize meal with vitamin A. According to the Ministry of Health and Childcare, one in every five children under the age of five years, and one in four women of child bearing age (15 – 49 years) suffers from vitamin A deficiency. Vitamin A deficiency is the leading cause of preventable blindness globally, children who suffer from vitamin A deficiency also have 25% greater risk of becoming severely ill and dying from common childhood diseases such as measles, malaria, or diarrhoea compared to those without VAD. It is also a leading cause of night blindness in women.

The orange maize was developed through a process known as biofortification, which is the conventional (non-GMO) breeding of staples to contain high levels of key micronutrients without compromising on yield and other farmer desired traits. The other biofortified varieties currently available in Zimbabwe are of Iron beans, the most popular variety being NUA45, and orange-fleshed sweet potato.

There has been a steady growth in the area planted to orange maize throughout the country, with farmers selling their surplus to the Grain marketing board (GMB). Zimbabwe currently has grading standards for non-biofortified white maize and yellow maize, but not for orange maize. As a result, all orange maize delivered to the GMB is graded as non-biofortified yellow maize. There is therefore a need to develop separate grading standards for the orange maize to promote its production, consumption and commercialization especially for humans as opposed to main livestock use being experienced with yellow maize. Grading can contribute to pricing efficiency by providing a quality base for market reporting on prices and supplies, by providing a basis for trading, by permitting buyers to systematically choose among qualities according to their preferences, and by aiding sellers to receive prices reflecting the value of their commodity.

2. The legal implications of grading standards

In most countries, maize grading standards are set by a grain regulating institution, and are normally gazetted as a government statutory instrument and therefore legally binding. In Zimbabwe, the standards are set in Statutory Instrument 140 of 2013, also referred to as Agricultural Marketing Authority (AMA) by-laws. Acceptance of the any suggested grain grading standards resulting from this work might entail a policy perspective in that it might have to go through a legal due process before being implemented.

2.1 Technical grading standards for white and yellow maize

Yellow, orange and white maize cobs.

There is a distinct difference in colour between yellow and orange maize as shown in Fig 1, in addition to the difference in pro-vitamin A (derived from β-carotene). With some technical training, staff responsible for purchasing of maize are able to distinguish between yellow and orange maize. However, despite this, there is no evidence from literature search of countries or institutions that have established grading standards for orange maize separately from white and yellow maize.

This section explains the general standards obtaining in different countries. Table 1 shows the grading standards for Grain Marketing Board (GMB) for white and yellow maize.

Table 1: ***Grading standards for unmixed white and yellow maize***

Grade	A	B	C	D	UG
Moisture content (%max)	12.5	12.5	12.5	12.5	12.5
Test Density (kg/hl min)	70	68	66	66	<66
Extraneous matter (%max)	0.5	0.75	1.0	4.0	>4.0
Trash (% max)	0.1	0.1	0.25	0.3	>0.3
Broken + Chipped (%max)	8.0	8.0	8.0	8.0	>8
Brown pigmented (%max)	6.0	8.0	8.0	8.0	>8
Defectives (%max) Discolored, diseased, insect damaged, shrivelled, stained, undeveloped	6.0	12.0	17.0	22.0	-
Aflatoxin (ppb-max)	20.0	20.0	20.0	20.0	>20.0

Source (AMA, 2013)

Table 1 shows the different grades and the technical considerations made in arriving at the particular grades. These include moisture content, test density, extraneous matter, the defectiveness of the grains as well as the level of aflatoxins (AMA, 2013).

Though Southern Africa is yet to standardize its grading systems for maize grain, other regions have done so, for example, East Africa has harmonized its grading standards. Table 2 compares the East Africa Standards (EAS) with the Zambian maize commodity exchange (ZAMACE) and codex (the international commodity exchange). It is noted that there are some huge differences among the different grades depending on the source (Keyser, 2012). The EAS was used since it is noted that

COMESA, of which most East African countries are also part of, is moving towards harmonization of grain standards and the chances of adopting EAS are higher as Southern Africa do not have common standards for grains.

Table 2: ***Comparison of EAS, ZIMACE and Codex Standards for White and Yellow Maize***

	EAS			ZAMACE			Codex
	Grade 1	Grade 2	Grade 3	A Grade	B Grade	C Grade	
Moisture content (max)	13%	13%	13%	12.5%	12.5%	12.5%	15%
Aflatoxin (max)	10ppb	10ppb	10ppb	n/s	n/s	n/s	Set by commission
Aflatoxin B1	5ppb	5ppb	5ppb	n/s	n/s	n/s	
Fumonisin	2ppb	2ppb	2ppb	0.5	0.5	0.5	
Foreign matter	0.5%	1%	1.5%	1%	1.5%	2%	1.5%
Inorganic matter	0.25%	0.5%	0.75%				0.5%
Broken grains	2%	4%	6%	6%	7%	8%	6%
a. Insect damaged grains	1%	3%	5%	3%	6%	9%	7%
b. Rotten diseased grains	2%	4%	5%	2%	2%	2%	7%
c. Discolored grains	0.5%	1%	1.5%	3%	6%	9%	2%
d. Other colored grains	-	-	-	3%	4%	5%	-
e. Fungal damaged grains	-	-	-	0.5%	1%	1.5%	-
f. Immature/shriveled grains	1%	2%	3%	1%	1.5%	2%	-
Total defective grains	**4%**	**5%**	**7%**	**11%**	**18.5%**	**26%**	-
Germinated grains	n/s	n/s	n/s	Nil	Nil	Nil	
Pass through 4.156mm	n/s	n/s	n/s	1.5%	2%	2.5%	
Diplodia (ear rot)	n/s	n/s	n/s	Nil	Nil	Nil	
Filth	0.1%	0.1%	0.1%	n/s	n/s	n/s	0.1%

Source: Kayser (2012)

2.2 Grading standards for orange maize

In Africa, countries that adopted biofortified orange maize early are Nigeria, Ghana, Kenya, Malawi and Zambia. A search of literature has shown no evidence that any of these countries have set up grading standards for orange maize. It is imperative to then establish the major considerations for orange maize grading. The Department of Agricultural Research and Specialist Services (DR&SS) has indicated that moisture content, test density, levels of aflatoxins and the levels of pro-vitamin A should be given important considerations for orange maize grading. The GMB recommended adoption of the same grading standards used for white and yellow maize and then include colour shades. Studies done on other crops with high levels of pro-vitamin A (derived from β-carotene) such as carrots, sweet potato and paw paw has shown that the stronger the orange shade, the higher the level of β-carotene.

According to Mezzemo and Ferreira (2016), darker colours are associated with higher levels of pro-vitamin A carotenoids, implying that the darker the shade of colour, the higher the level of the β-carotenes. The proVitamin A carotenoid levels in yellow maize are less than 2ppm while those in orange maize range from 7-15ppm, hence the lighter yellow shed of yellow maize compared to the darker, more orange shed for orange maize. This shade of colour can be used to distinguish between yellow and orange maize. Shades of β-carotene have been used before to grade the levels of vitamins in sweet potatoes and it is possible to use that also in orange maize grading. However other authors like Pillay et al (2013) have argued that intensity of colour does not really determine pro-vitamin A

content in maize because of variable accumulation in the maize kernel (seed coat, endosperm and germ).

2.3 Relative pricing of orange maize

Studies from Zambia (Sipungwe et al, 2017) have shown that biofortified orange maize can be grown without affecting productivity levels obtainable in traditionally grown white maize. However, in the study by Muvhiringi and Chigede (2021) in Mazowe district, farmers who had grown orange maize indicated that they obtained lower yields than what they traditionally obtain with white maize. It is important however to note that the maize varieties that are mostly grown in Mazowe, a high rainfall area in natural farming region II are the late maturing ones that are normally higher yielding than the early maturing varieties that perform better in natural farming regions III - IV. Orange maize varieties are early maturing and according to DR&SS, their yield potential is similar to or even higher than that of white maize varieties in the same maturity group. The same study also showed disappointment of farmers on being paid the same price by GMB for the orange maize as is with white maize. So the question is whether orange maize should have premium pricing compared to white and yellow maize in light of possible nutritional benefits that is offers. If a premium is offered, another issue is the level of premium and the implications that this will have on producers, processing companies and consumers, given the promotion drive for biofortified orange maize use. For example, Ekpa *et al* (2018) noted that consumers needed an average price discount of 37% in Kenya, 30 - 40% in Mozambique and 10% in Zimbabwe to accept yellow maize instead of white. However, when nutritional information was provided, while promoting orange pro-vitamin A bio-fortified maize in Zambia, the consumers preferred and were willing to pay a premium for orange maize varieties. In Ghana, prices for orange maize were 20-30% more than that for white maize (IITA, 2017). A study by Meenakshi et al (2010), showed that with consumers having information on nutrition of orange maize, they are willing to pay a premium between 15-32%. DR&SS has also suggested that a premium of 25% for orange maize compared to white maize to compensate for the isolation distances that could be required to prevent discolouration of white maize grown adjacent to the orange maize.

3. Conclusion

There is no evidence of a grading system for orange maize internationally. Important considerations for grading of orange maize could be moisture content, test density, levels of aflatoxins and the presence of pro-vitamin A carotenoids beyond a certain threshold. The amount of pro-vitamin A carotenoids might be estimated from the level of intensity of the orange shade, though without appropriate laboratory equipment, this might difficult to implement. However visually, it is possible to distinguish orange maize from white maize. While it is accepted that promotion of production of orange maize would require a producer price premium, studies are mixed on the impact to processors and consumers, with some indicating consumers would require a discount and others pointing to acceptance of a premium in consumption of orange maize.

4. Recommended grading standards for orange maize

- It is recommended that the current grading standards for white and yellow maize be adopted for orange maize.
- In addition, orange colour should be used as an indicator for the presence of the minimum acceptable pro Vitamin A carotenoid threshold to separate orange from yellow maize.
- GMB staff responsible for grain grading a Depot level should undergo training on differentiating orange from yellow maize.
- A producer price premium is also recommended to promote increased production of orange maize given pro-vitamins benefit obtained from the grain. A starting premium as suggested

by stakeholders and studies from other countries is between 15-25% relative to the price of white maize.

- There is need for national marketing programs to raise awareness to consumers of the benefits of orange maize to strengthen demand driven value chain given the suggested premium on the product.

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