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SOIL & CROP SCIENCES | RESEARCH ARTICLE

Trends in production and consumption of selected biofortified crops by rural communities in Zimbabwe

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Abstract: Poor dietary diversity is one of the leading causes of high rate of malnutrition in rural communities. Biofortification provides a solution for global micronutrient deficiency through consumption of crops rich in essential micronutrients. This study sought to assess trends in production and consumption of selected biofortified crops by rural communities of Zimbabwe. Information was collected from farmers and district food and nutrition security committee through seven

ABOUT THE AUTHORS

Prosper Bright Muvhuringi is a Lecturer at Africa University. He has vast experience in working as a Principal Livestock Specialist in the Ministry of Lands, Agriculture, Water and Rural Resettlement. He is currently the Chairperson of the District Food and Nutrition Security Committee (DFNSC) in implementing Multi-sectoral Community Based Model (MCBM) for reduction of stunting. As part of DFNSC, he implements nutrition-specific and nutrition-sensitive interventions to improve the livelihoods of the rural populace. He is a holder of Master of Science in Animal Science, Bachelor of Science Honours degree in Agriculture, Bachelor of Social Science Special Honours in Monitoring and Evaluation Studies, International Diploma Animal Feed. Lastly, he executes part time tutoring at Zimbabwe Open University.

Ngavaite Chigede is a Lecturer at Great Zimbabwe University in the department of Livestock, Wildlife and Fisheries. He is experienced in animal production aspects. He has worked before as a lecturer in animal production at Chibero College of Agriculture in the Ministry of Lands, Agriculture, Water and Rural Resettlement. He is a holder of Master of Science in Animal Science, Bachelor of Science Honours degree in Agriculture (Animal Science). In partnership with AGRITEX, we conduct researches which are intended to improve and monitor production practices and welfare of the general public and inform responsible authorities. The current research is conducted as part of our duties to inform the government and funders of the level of impact the program has had on the intended community and recommend on ways to accelerate the benefits.

PUBLIC INTEREST STATEMENT

Hidden hunger is a major concern in rural communities of developing countries. Addressing this challenge will go a long way in mitigating deaths of children under five linked to malnutrition. In Zimbabwe, the staple crops are maize and beans which is used as relish to be taken together with the sadza. Biofortification of maize and beans will address hidden hunger since the majority of rural Zimbabweans rely on these crops. The government of Zimbabwe, through non-governmental organizations, introduced biofortified crops to the rural communities in Zimbabwe, at a lower scale with the hope and trust that people will share the seed as they do normally in their communities, thereby spreading the biofortified crops and improve their consumption and consequently reducing hidden hunger effects. This research sought to assess trends in adoption and use of the biofortified maize and beans since its introduction in year 2015 and inform policy developers accordingly.

focus groups using open-ended questions and key informant interviews to determine the knowledge, production and consumption patterns of biofortified crops. A survey was conducted using a questionnaire to gather quantitative data such as sources of knowledge, production and consumption patterns of biofortified crops. Secondary data on biofortified crops production was obtained from the AGRITEX department. This study revealed that biofortified crops production and consumption were low due to factors such as unavailability of biofortified seeds, poor yields of the orange maize variety, low producer price at the Grain Marketing Board, and failure by farmers to distinguish orange maize from yellow maize. Few people had consumed biofortified beans and orange maize. To combat hidden hunger, the research recommends promotion of biofortified crops production through public media and inclusion under government programs targeted to boost food production such as command agriculture.

Subjects: Agricultural Development; Agriculture and Food; Nutrition; Rural Development; Nutrition and Dietetics

Keywords: Biofortification; Orange Maize; Iron Beans; Malnutrition; Hidden Hunger

1. Introduction

Micronutrient deficiencies affect more than two billion people globally contributing to about 45% of all child deaths in developing countries (Fao & Wfp, 2015). Approximately one-third of children under the age of five are at risk of Vitamin A deficiency (WHO, 2009). The most people at risk of micronutrient deficiencies are pregnant women and children under the age of five. Millions of people in Zimbabwe (mainly women and children) suffer from various forms of malnutrition which include stunting, anaemia, low birth weight, underweight, wasting and deficiencies of vitamins and minerals (GoZ, 2018). In Zimbabwe, almost one in every five children under the age of five is vitamin A deficient (LFSP, 2019). The same applies to women of child bearing age (15–49 years old). The Government of Zimbabwe (GoZ) demographic and health survey 2015, indicated that more than 33% of the children under five and 27% of women are anaemic (Zimbabwe National Statistics Agency and ICF International, 2016). This results in too much pressure being exerted to the health system through short-term effects such as increased risk to infection and long-term effects for example, retarded growth and development of the nation.

A study by Zuma et al. (2018) showed that micronutrient deficiency mainly affects the rural populace who mainly consume cereals such as maize on day to day basis. This can be reduced substantially in the long term if there is an increase in production and consumption of micronutrient-rich foods (H.E Bouis et al., 2011b). Sharma et al. (2017) highlighted that poor dietary diversity and high dependence on calorie diets are the major causes of malnutrition in Asian and African countries. Improved dietary needs of the poor rural communities in most developing countries are successfully met by paying attention to the production of biofortified crops. This is in agreement with Bouis and Saltzman (2017a) who aver that biofortified crops provide the feasible means of reaching rural communities with less access to diverse foods. Biofortification is the process of conventionally breeding food crops that are rich in micronutrients, such as vitamin A, zinc, and iron (LFSP, 2019). It provides a comparatively cost-effective, sustainable, and long-term means of delivering more micronutrients (H Bouis et al., 2013).

Agricultural production should not only focus on producing more calories to reduce hunger since it provides inadequate solution to hidden hunger but to produce more nutritious food crops with high levels of essential micro-nutrients (Johns & Eyzaguirre, 2007; Kennedy et al., 2003; Sharma et al., 2017). The biofortification strategy seeks to put the micronutrient-dense trait in those varieties that already have preferred agronomic and consumption traits, such as high yield. In Zimbabwe most people consume maize and if biofortified, it can provide 50% of the vitamin A requirements (LFSP,

2019). Many rural communities grow and consume ordinary beans frequently (LFSP, 2019). High iron beans contain double the iron and zinc which are found in ordinary beans (LFSP, 2019) hence promotion of biofortified beans can reduce deficiencies of minerals such as iron and zinc. An assessment of bioavailability of vitamin A equivalency in beta carotene in orange maize which was conducted in US women and Zimbabwean men showed that beta carotene in orange maize is converted efficiently to vitamin A in the body suggesting that regular consumption of orange maize improves Vitamin A status in communities (Talsma, 2017). A positive change in liver reserves was observed in children who consumed orange-fleshed sweet potato (Van Jaarsveld et al., 2005)).

Vitamins and minerals are required in small amounts but are very important in development, disease prevention and general well-being (LFSP, 2019). The body cannot synthesize adequate quantities of all the micronutrients it requires hence there is need to supplement them through the diet. Orange maize contain higher beta carotene levels compared to the ordinary white maize (Zuma et al., 2018). Although biofortification is not the only solution to address undernutrition, it is one component of a comprehensive food based approach that improves the nutrient value of foods that lack certain micronutrients (H Bouis et al., 2013). Globally, micronutrient density has been successfully increased through conventional breeding of staple foods without negatively impacting on other farmer preferred characteristics (H Bouis et al., 2013).

The Livelihoods and Food Security Program (LFSP) aims to contribute to poverty reduction through increased agricultural production, increased incomes, and improved food and nutrition security for smallholder farmers. Promotion of nutrition-sensitive interventions such as increasing production and consumption of nutritious foods by rural communities is another mandate of LFSP. Biofortification strategy has proven to be an appropriate strategy in other developing countries and has gained ample recognition as a cost-effective, complementary, feasible means of delivering micronutrients to malnourished populations that may have limited access to diverse diets, supplements, or commercially fortified foods (Andersson et al., 2017; H Bouis et al., 2013; LFSP, 2019; Sharma et al., 2017). Since 2007 to date, biofortification has successfully been achieved in most consumed crops such as sweet potato, maize, cassava, beans, rice, pearl millet and wheat (H Bouis et al., 2013).

In Zimbabwe, the Provitamin A variety germplasm was introduced in 2013 in partnership with HarvestPlus through CIMMYT Mexico (Braizer, 2014). HarvestPlus is a technical partner to government and other non-governmental organizations (NGOs) in implementing agricultural projects specializing in biofortification. The Zimbabwean government launched a fortification strategy due to higher deficiency rates of micronutrients. Biofortification was incorporated as a food-based solution to malnutrition. In an endeavor to drive food and nutrition security and resilience, the government of Zimbabwe has included biofortification in the National Agriculture Policy Framework 2019 to 2030 (Katsi, 2020). It was expected that by year 2020, 400 000 smallholder farmers should be growing and consuming biofortified crops in the country (Katsi, 2020). Farmers can obtain seed from the market place or they could get it from HarvestPlus organization if they happen to be among the beneficiaries. Seed is also expected to be moved as gifts from those households who would be having more of the seed. Some households could use returned seed.[1]

Market of agricultural produce can be a challenge if farmers venture into production without proper marketing channels. However, farmers who produce biofortified maize and beans in excess were expected to sale it to Sky Brands, an organic biofortified and traditional food processing company, in addition to the Grain Marketing Board, a Zimbabwean government parastatal that buys crop produce from farmers around the country and performs the distributive role of the produce.

This study sought to assess trends in production and consumption of bio-fortified crops by rural communities in Zimbabwe who were introduced to biofortified crops through non-governmental organization, HarvestPlus since 2016. Findings from the current survey will help policy makers and implementers of biofortification program to assess the trajectory of the program and expected impacts in the long run.

The following section, methodology, describes how the data were collected and analyzed. This is followed by results and discussions and lastly, conclusions and recommendations are made based on research outcomes.

2. Methodology

2.1. Study site

The current research was carried out in Mazowe District which falls under agro-ecological region IIa with an annual rainfall range of 800 mm to 1200 mm (Vincent & Thomas, 1960). The district is one of the high crop-producing districts in Zimbabwe. Crops grown in the district include: maize, soybeans, wheat, sugar beans, mbambara nuts, ground nuts, cotton, tobacco, sunflower, millets and a wide range of horticultural crops. Although the district is the biggest crop producer, it has high levels of malnutrition of children under the age of five. The Zimbabwe Vulnerability Assessment Committee (ZIMVAC[2]) (Zimbabwe Vulnerability Assessment Committee (ZIMVAC), 2019) executed rural Livelihoods Assessment and indicated that Mazowe District has about 28% levels of stunting. Mazowe District is also one of the twelve districts which piloted the biofortification programme under the Livelihoods Food and Security Programme (LFSP). Through support from HarvestPlus, the Agriculture Technical and Extension Services Department (AGRITEX[3]) distributed seed test packs of selected biofortified crops (orange maize and iron beans) to 12 selected districts since 2016 and the districts were selected based on levels of stunting (hidden hunger) as well as crop production capacity. Cumulatively, seed packs amounting to 259 metric tonnes of vitamin A orange maize and 400 metric tonnes of iron beans have been distributed across the country through a combination of direct distribution and market-led interventions. More of vitamin A orange maize and iron beans because of their potential impacts as staple crop and beans as a relish for the majority in communal areas since other rich sources of micronutrients are out of the reach of many in rural communal areas (Matsungo et al., 2018).

2.2. Target population and sampling procedure

The 13 communal wards in Mazowe district were the target population.

Six wards, 3, 4, 6, 8, 11 and 12, were randomly selected for questionnaire administration through face to face interviews and focus group discussions. In each ward, there was a sample of beneficiaries of the HarvestPlus biofortification programme. Purposive sampling was used to select the participants for all the focus group discussions from the six wards. Stratified random sampling technique was used in which farmers were grouped into two (those who once produced biofortified crops (beneficiaries) and those who had never produced biofortified crops (non-beneficiaries)). Simple random sampling technique was then used to select 10 communal farmers[4] from each category making a total of 20 farmers per ward.

2.3. Study design

Mixed research approach was employed. The study triangulated quantitative and qualitative research methodologies.

2.4. Data collection methods

Focus group discussions (FGDs) and Key informant interviews were used to collect qualitative data whilst the survey method collected quantitative data. Secondary data on production of crops was gathered from AGRITEX. Data collection was done during the period from 2 January 2020 to 30 March 2020. The research was conducted in local language (Shona) to accommodate each respondent. The researcher developed FGD guide, semi-structured questionnaire and key informant guides which were pre-tested to identify errors such as ordering and ambiguity in questions. Necessary alterations in wording were done.

2.4.1. Focus group discussions (FGDs)

Seven FGDs were carried out by a skilled moderator and the researcher. The moderator guided the data collection process which was interactive and centered to the key issues of production

(farmers' perceptions on production of biofortified crops, challenges faced during production of biofortified crops, how to intensify production of biofortified crops) and consumption (farmers' perception on the level of consumption, factors limiting consumption, suggestions to improve consumption) of biofortified crops by rural communities. FGDs were lasting for 1 hour to 1 hour 20 minutes. The first FGD was conducted with the DFNSC.[5] The FGD comprised 11 representatives from each of the following government ministries and the private sector: the Department of Agriculture Technical and Extension Services (AGRITEX), Grain Marketing Board (GMB), Ministry of Health and Child Care (MoHCC), Ministry of Local Government (MLG), Ministry of Public Service, Labour and Social Welfare (MPSLSW), Department of Research and Specialist Services (DR&SS), Ministry of Women Affairs, Small and Medium Enterprises (MWASME), Ministry of Primary and Secondary Education (MPSE) and the Ministry of Youth, Arts and Culture (MoYAC), Environmental Management Agents (EMA) and Forestry Commission.The ministries and private sector organizations chosen are part of the District Food and Nutrition Committee which is involved in the implementation of nutrition-sensitive and nutrition-specific interventions such as promotion of production and consumption of biofortified crops in the district. Involvement was either through distribution of biofortification inputs and monitoring of the program or involvement in the actual production.

2.4.2. Key-informant interviews

The local leaders such as traditional leaders (headman) and religious leaders were purposefully selected from the six randomly selected wards. Every developmental intervention within an area comes through the traditional leaders, hence the decision to choose them as key informants since they will be well informed and knowledgeable about what will be going on in their communities. The key informants highlighted challenges faced in implementing biofortification and recommendations to improve adoption of biofortified crops.

2.4.3. Household survey

Household survey with farmers was conducted by well-trained enumerators from the AGRITEX using a semi-structured questionnaire to collect data such as the household demographic, farmers' knowledge and source of knowledge about biofortified crops, taste preferences, source of seed for biofortified crops, level of production, consumption and marketing of biofortified crops produce. A total of 120 communal farmers were interviewed.

2.4.4. Secondary data

Production records from 2016/17 season to 2019/20 season were obtained from AGRITEX through its ward extension staff. The records included land area cultivated for each crop. The national statistics on seed distribution of biofortified crops was obtained from HarvestPlus.

2.5. Data analysis

Statistical Package for Social Sciences (SPSS) version 21 was used to analyze quantitative data on evaluating the adoption rate of orange maize production and consumption view by rural communities of Zimbabwe. Data was entered on SPSS and data cleaning was executed on errors identified and were corrected. Data ranges in numerical values were used to eliminate erroneous data as a result of mistakes made during coding. SPSS generated frequency distributions of the knowledge and source of knowledge about biofortified crops, production and consumption levels of biofortified crops, taste preferences, source of seed for biofortified crops and marketing of biofortified crops produce. Association between gender and consumption of biofortified crops (orange maize and biofortified beans) was determined through cross tabulations and chi-square test. Qualitative data obtained during the FGDs and key informant interviews was transcribed and typed. The findings expanded the findings from the quantitative data as well as complementing explanations obtained from household questionnaires. Quotes were also used to present the data.

Table 1. Demographics and socio-economic characteristics of households in Mazowe district, Zimbabwe

Characteristics	Percentage
Age (years) 15–24 25-49 >49	18.3 44.2 37.5
Total	**100**
Sex Male Female	40.0 60.0
Total	**100**
Level of education None Primary Secondary Tertiary	10.8 30.0 51.6 11.7
Total	**100**

(n = 120)

2.6. Ethical considerations

The researchers sought permission to carry out the study from the Mazowe District Local Government authorities which then generated a permission letter for researchers to execute data collection in each rural ward. The rural communities participated willingly since the study ensured that there was freedom to withdraw from participation at any stage. Participants voluntarily consented to participate without coercion after a brief introduction of the study objectives by the researchers. The study adhered to research principles pertaining to privacy and confidentiality as well as anonymity.

3. Results and discussion

The majority of the respondents were aged 25–49 years (Table 1).

Farmers were categorized into three age groups based on the assumption that, 15–24 year age group will still not be decided whether to fully devote their time to agriculture or not. The 25–49 age group will have decided on what to do for their living and future and also the physical strength required for agricultural production culminates in this middle age (Guo, Wen, & Zhu, 2015). Above 49, productivity will be on the decrease. The highest proportion (60%) of the respondents were female farmers. This is in line with SOFA team and Doss, (SOFA Team and Doss S, 2011) who asserted that women contribute significantly to agriculture

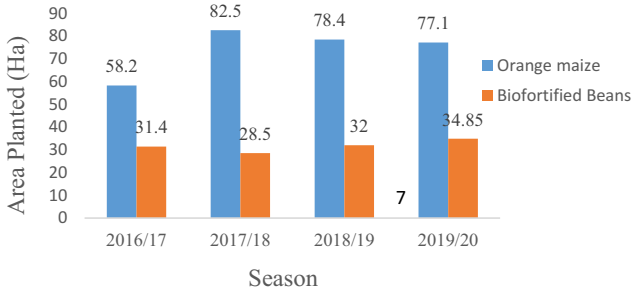

Figure 1. Production trends of biofortified crops from year 2016 to 2020.

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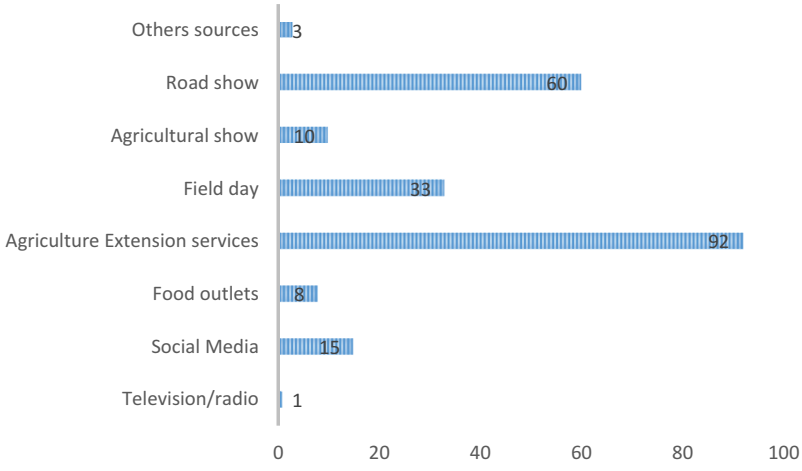

Figure 2. Percentage distribution of the respondents' source of knowledge of biofortified crops (*n = 120 multiple response*).

Table 2. Distribution of the respondents' source of biofortified crops seed

Source	Percentage
Contracted by HarvestPlus	80
Returned Seed	14
Purchases from Distant market (out of ward)	26
Purchases from nearby market (within ward)	4
Gifts or remittances	20

and food production and comprise half or more of the agricultural labour force in the majority of African and Asian countries. Basavaraj and Babus (2018) suggested that women contribute enormously to agricultural growth and development as well as agricultural workforce (50%) in most developing countries. It was interesting to note that the majority of the farmers (52%) had reached secondary level of education. This could mean that the farmers are trainable if technical skills to do with production of biofortified crops are to be brought in.

Production records collected from the AGRITEX department, indicated that orange maize and biofortified beans production was effected starting year 2016. During the inception of the programme, HarvestPlus supplied 4 metric tonnes of orange maize seed and 4 metric tonnes of biofortified beans test packs in 2016/17 season as well as in 2017/18 season. In 2018/19 season HarvestPlus supplied only 1.65 metric tonnes of orange maize and 1.65 metric tonnes of biofortified beans. The test packs supplied by HarvestPlus were distributed equally in the 13 rural wards. The highest area planted for orange maize was attained in 2017/18 season followed by 2018/19 season. From 2016 to 2020, the biofortified beans area planted ranged from 28.5 to 34.85 hectares whereas that of maize ranged from 58.2 to 77.1 hectares.

More than 80% of the orange maize and biofortified beans planted during the 2019/20 cropping season was among the communal households.

More maize crop was planted in all seasons from year 2016 to 2020 (Figure 1) compared to beans.

Matsungo et al. (2018), argues that biofortification will impact the majority if implemented through staple diets such as maize, which are consumed by the majority in Zimbabwe and other sub-Saharan African countries.

3.1. Source of knowledge of biofortified crops

The study indicated that agricultural extension services play a major role in imparting knowledge of biofortification (Figure 2).

Although the television and radio are effective in dissemination of information in some instances, only 1% had received knowledge through such media. There is need to promote use of television and radio so that it contributes more as more households have access to the gadgets. Also training on nutrition and home visits are critical to create awareness among rural communities and for the success of biofortification as alluded to by Sharma et al. (2017).

HarvestPlus is the major source of seed for the farmers in Mazowe district (Table 2).

(*n = 120 multiple response*)

A relatively smaller proportion (26%) is able to buy the seed for themselves. There is need to increase awareness among farmers so that the proportion which buys the seed on their own increases, thus a correspondingly increased production and consumption of biofortified crops. On the other hand there is also need to increase production capacity of the seed locally thereby increasing opportunities along biofortified crop value chains as alluded to by Matsungo et al. (2018).

3.2. Production of biofortified crops

A focus group discussion with the District Food Nutrition and Security Committee (DFNSC) revealed that most farmers are not growing biofortified crops. This is in agreement with the findings of the National Nutrition Survey (2018), which indicated that only 33% of the households which were aware of biofortified crops had grown or purchased biofortified crops within a period of 6 months. The chairperson of the DFNSC highlighted that most of the production of biofortified crops is done in the communal farming sector (wards 1–13). In the commercial sector (wards 14–35) only institutions were found to carry out production of biofortified crops. It was further alluded that since the inception of the biofortification program, promotion of biofortified crops was mainly done in the communal areas. This is in line with Zuma et al. (2018) who asserts that the resource-poor communal farmers are the ones more prone to hidden hunger hence the need to promote adoption of biofortified crops more in these areas than commercial areas. The DFNSC committee further indicated that the major hindrances to adoption of production of biofortified crops are unavailability of seed, high cost of seed, poor markets and less knowledge of the benefits of biofortification. Most farmers grow maize mainly as an energy source and for commercial purposes. Therefore, when farmers consider the maize variety, they focus more on yield potential as compared to nutritional and health benefits. The DFNSC committee also highlighted that average yields of the newly introduced orange maize varieties (5 tonnes/ha) are lower than the medium and long season white varieties. Sharma et al. (2017) suggested that biofortified crops must achieve high yields and profitability to the farmer so as to lure them to produce more.

The DFNSC agreed that production of biofortified crops is a better intervention to reduce malnutrition mainly to the rural populace who rely more on crops such as maize and sweet potato among other crops. This is in agreement with Gani et al. (2018) who highlighted that biofortification is sustainable and relies on foods, which people already eat habitually. Gani et al. (2018) further asserted that seeds, roots, and tubers can be saved by farmers and shared with others in their communities thereby reducing costs in the long run. In 2008, biofortification was rated fifth among the most cost-effective solutions to address global challenges such as reducing hidden hunger (Andersson et al., 2017). The DFNSC committee suggested inclusion of the production of biofortified crops under the government's command agriculture programme as well as promoting adoption through the public media.

It was universal in all the seven FGDs which were conducted, that the following reasons were the major causes of low production of biofortified crops in the rural communities: unavailability of biofortified

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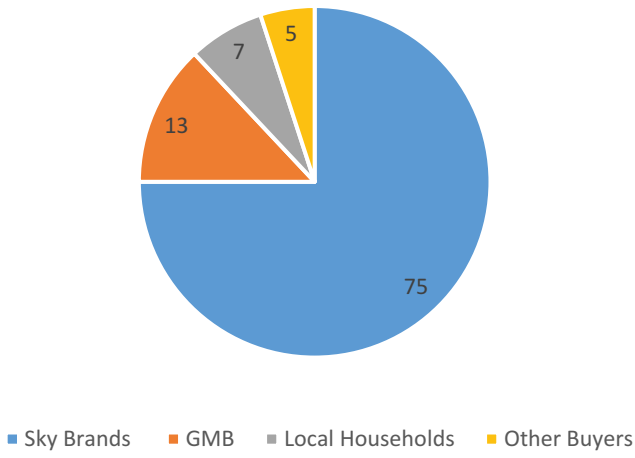

Figure 3. Percentage distribution of the respondents' main market for Orange maize.

seeds, poor yields of the initially introduced orange maize variety, low producer price at the Grain Marketing Board, farmers' inability to distinguish yellow maize from orange maize and distance to seed markets. This is in line with LFSP (2019), who highlighted that the color of orange maize closely resembles yellow maize which was distributed during a drought relief programme in 1992–1993 and the majority of the Zimbabwean populace disliked its taste and flavor. One woman in ward 3 asserted that:

> *"We want to produce orange maize and iron beans but the distance to the seed market place is too long and very expensive. If the market place was at our local shops, I tell you most farmers will produce the biofortified crops"*

In view of the assertion of some respondents from ward 3, the government should subsidize biofortified inputs in trying to increase adoption of the crops. Seed companies should also consider stocking the seed close to the farmers so as to cut on distance to the market. These measures will go a long way in enforcing widespread adoption which Nestel et al. (2006), recommended for biofortification strategies.

Although the majority of the participants on a Focus Group Discussion in ward 12 agreed that orange maize is a good crop with several benefits in terms of nutrition and health, a young man stood up and argued:

> *"The crop is useless, I grew it for two consecutive seasons but the yields were too low. We are used to the varieties which give us much yield per hectare. With this orange maize, you can make a loss"*

Farmers' criteria for changing varieties include food and income security, risk factors that are balanced against increased farm revenue through increased production or improved production efficiency and economics as a consequence of adopting a new technology. Therefore, seed breeders should improve yield performance of biofortified crops to give food security to those farmers who opt for the biofortified varieties.

Low adoption rate which was highlighted in all the six focus group discussions was substantiated by the key informants. A traditional leader in ward 8 reported that production of biofortified crops was being done by few farmers in the ward and the district at large. He stated that production of biofortified crops should have been advertised even on national television and radios so that the knowledge spreads to almost every individual. A religious leader in ward 3, stated that test packs which were provided by the AGRITEX in 2016/2017 season targeted few farmers and during that period the farmers could not distinguish orange maize and yellow maize. The key informants in the selected wards shared the same sentiments with what was highlighted as major causes of low

production of biofortified crops that is unavailability of biofortified seeds, poor yields of the initially introduced orange maize variety, low producer price at the Grain Marketing Board, farmers' inability to distinguish yellow maize from orange maize and distance to seed markets. A representative of the traditional leadership in ward 6, highlighted during an interview that the programme was not participatory. He asserted:

> *"We were not consulted about this programme. The local extension worker just brought us the orange maize and told us to grow if we had available land. We didn't know much about the crop, we thought it was yellow maize so we just planted a small portion and kept the remaining seed"*

There is need to engage local communities from the leadership down to the households. This will ensure that the community is not caught by surprise on new developments in their area as they feel party of the initiatives thus guaranteed higher adoption rates of the initiative in the area. The majority of the Zimbabwean populace did not like the flavor and taste of yellow maize (LFSP, 2019). To motivate the rural populace to opt for biofortified and better nutrition foods, awareness is fundamental among the consumers (Stein et al., 2006).

On a positive note, all the six key informants' interviews indicated that biofortified crops provide good nutrition to pregnant mothers and children below the age of five.

3.3. Consumption of biofortified crops

The DFNSC revealed that consumption of biofortified crops within the district is still very low. The District Nutritionist emphasized low consumption of biofortified foods highlighting that even the ZIMVAC rural livelihoods assessment in 2019 indicated a low consumption of biofortified foods. It was universal on all the Focus Group Discussions that consumption of biofortified beans and orange maize is still very low. FGDs indicated that some farmers were not consuming the biofortified crops they produce. A certain man asserted:

> *"I harvested and delivered all the orange maize I produced to GMB. I anticipated that the price of orange maize was higher than white maize. Surprisingly, I was paid the same amount".*

There is need to educate communities on benefits of biofortified crops so that they do not sale all their produce after harvests. Value addition of the crops like their use in baking can be advocated for to promote widespread consumption in communities. Three FGDs revealed that food outlets were selling orange maize "sadza" (thick porridge) as well as cooked biofortified beans. A religious leader asserted:

> *"I came across these biofortified beans and orange maize when I bought food at the local shops. That was the first time I consumed them."*

When asked about whether the farmers had consumed biofortified crops, 67% confirmed that they had consumed orange maize whilst 33% had not consumed orange maize. The study' Chi-square test results indicated that there was no association ($p > 0.05$) between gender and consumption of biofortified crops. However, orange maize was consumed by only 30% of those who had never produced orange maize. It was interesting to note that all the farmers who were producing orange maize, had consumed it. Biofortified beans were consumed by 10% and 60% of non-producers and producers of biofortified beans, respectively.

3.4. Main market for orange maize

Sky Brands was the major market (75%) for orange maize for the communal farmers (Figure 3).

The contract which was offered by HarvestPlus had arrangements that farmers will sell their products to Sky Brands hence the greatest share of the market. Grain Marketing Board, local households and other buyers were the source of market to 13%, 7% and 5% of the farmers who produced orange maize, respectively.

4. Conclusion and recommendations

The study noted that production of biofortified crops and consumption was low. However, a plethora of factors were highlighted to be the major hindrances to the production and consumption of biofortified crops. These were unavailability of biofortified seeds, poor yields of the orange maize variety, low producer price at the Grain Marketing Board, unable to distinguish yellow maize from orange maize and distance to seed markets. Due to low production trends, few people had consumed biofortified beans and orange maize.

Thus the research recommends promotion of biofortified crops through public media as well as inclusion of production of biofortified crops under government programs such as command agriculture. Subsidizing biofortified crop inputs will increase purchase of the seed and consequently land area allocated to biofortified crop production. This will subsequently result in increased production and consumption of biofortified crops. Setting up of retail outlets of biofortified food processing companies like Sky Brands should be promoted such that the generality of consumers are aware of the various products. Since the majority of pregnant women and children under the age of five are the most affected, MoHCC can be tasked to distribute a smaller packet of biofortified seed to every women who visit the hospital for check-up purposes. By doing so, distribution would have been done to the intended beneficiary and adoption rate gradually increases.

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Notes

1. Returned seed: refers to seed selected and preserved by farmers from last season harvests.
2. ZIMVAC is a technical advisory committee comprised of representatives from government, development partners, UN, NGOs, technical agencies and the academia.
3. AGRITEX is a department under the Ministry of Lands, Agriculture, Water, Fisheries and Rural Development mandated to disseminate agricultural information to farmers around the country.
4. Communal farmers are households in rural set-ups characterized by smaller land areas and low agricultural productivity.
5. DFNSCs are institutional structures at district level for coordinated multi-sectoral implementation of the Food and Nutrition Policy programs.

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