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Increased Sorghum (*Sorghum bicolor, L*) Productivity: Unlocking its potential for food crisis mitigation for small holder communal farmers in the Semi-Arid regions: A case of the Zambezi Valley Region in Zimbabwe

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ABSTRACT

This paper analyses current and projected trends of sorghum production in Mbire as influenced by the ZRBF programme from 2016 to 2020. Average cereal production in this district has been dominated by maize 56.01% with sorghum accounting for 43.99 % since 2015. Between 2014 and 2017 trends in area, production and yield of sorghum were negative but were positive from 2018 to 2020. Mean yield was 0.29 t/ha with upper and lower limits of 0.41 t/ha and 0.10 t/ha respectively. Trends in area planted under maize and sorghum in the district showed a gradual increase for sorghum from 7000ha in 2015 to approximately 12000 ha in 2020 and an inverse trend for maize from approximately 12000 ha to 7000 ha for the same period. Rainfall varied during these years with a mean of 702.3mm per year which was slightly above normal for the region. Sorghum was primarily used for food (62 %) whilst 28% was used for food processing with just 10% for animal feed and non- food uses. Trading of sorghum attached USD value over the years ranged between USD 240 to 290 per MT as officially communicated by GMB and Delta Beverages. There was a general positive trend in area planted under sorghum with corresponding increase in production indicating farmers' adoption of sorghum production. Increasing production of sorghum by 41.5% from the baseline scenario is forecasted by 2025. These results suggest that in future, sorghum will play an increasingly important role in food security of these communities.

Key Words: Sorghum, Trends, Yields, Food Security.

1. INTRODUCTION

Traditional grains are generally perceived as crops in terminal decline. **(**Orr A, Mwena C, Gierend A and Nedumaran S.2016). Production has been concentrated in marginal communal farming areas with little production in large scale commercial farming areas. Crop utilization has been limited to food, food processing and barely for livestock feed. Maize as a staple grain has been promoted in all facets in preference to sorghum and other traditional crops. High investments in varietal improvements, incentive accreditation, and crop management were more inclined to maize than to sorghum for the past three decades. However, with the advent of climate change and accompanying effects, a common phenomenon has recurred where maize crop failures due to droughts has left these communal farmers in a dreadful food insecurity situation. Now the question is, can maize production provide for the food needs of these communities whose populations also seem to be increasing continuously? Concern is growing that it may not. Maize staple production is vitally important to Zimbabwe's economy, but recently it struggles with challenges created by the country's wider economic crisis and has been hit hard by Southern Africa's persistent droughts as well.

In Zimbabwe, more than seven million people are facing food shortages after the worst drought the Southern African region has seen in 35 years (Zimbabwe Food Crisis Policy brief 2020). This figure is projected to increase to 58.8 million by 2030. In Zimbabwe the food crises deteriorate due to climate induced droughts, floods and cyclones for instance, the recently experienced cyclone Idai. The macro-economic situation in Zimbabwe has also exacerbated the situation coupled with the recent global pandemic of the corona virus (Covid -19). The COVID-19 pandemic severely threatens an already critical food security situation arising mainly from the prevailing poor macroeconomic conditions and consecutive years of drought. This has put the lives of millions of people and livestock at risk and abject poverty. This situation has left vulnerable groups especially women and children with negative coping mechanisms such as reducing the number of meals per day as smallholder communal maize farmers continue to fail to produce for subsistence. Market prices for grains has continued to rise beyond reach of many with maize recording the highest percentage increase of 53% in 2019. (World Food Programme Zimbabwe Monthly Food security Outlook, January 2020).

Heat and drought tolerant crops have been advocated for with the confidence that deliberate efforts towards increased crop productivity answers to the above scenario in semi-arid regions of Zimbabwe. In the face of global climate change and its effects, pillar 3 of Climate Smart Agriculture (CSA) focuses on crop productivity improvements. The Zimbabwe Agriculture Recovery plan specifically advocates for production of traditional grains such as sorghum, millet and cowpeas because of their drought tolerance. This paper is, therefore, a review of the sorghum production trend analysis and associated events in Mbire district with close reference to the current government of Zimbabwe's agricultural recovery plan and the ZRBF program.

2. Overview

2.1 The Context

Mbire district lies in the extreme northern part of Zimbabwe in the Zambezi Valley bordering with Mozambique and Zambia. There are localized patches of alluvial and colluvial soils mainly in the Zambezi valley. Figure 1 below illustrates the general location of Mbire district.

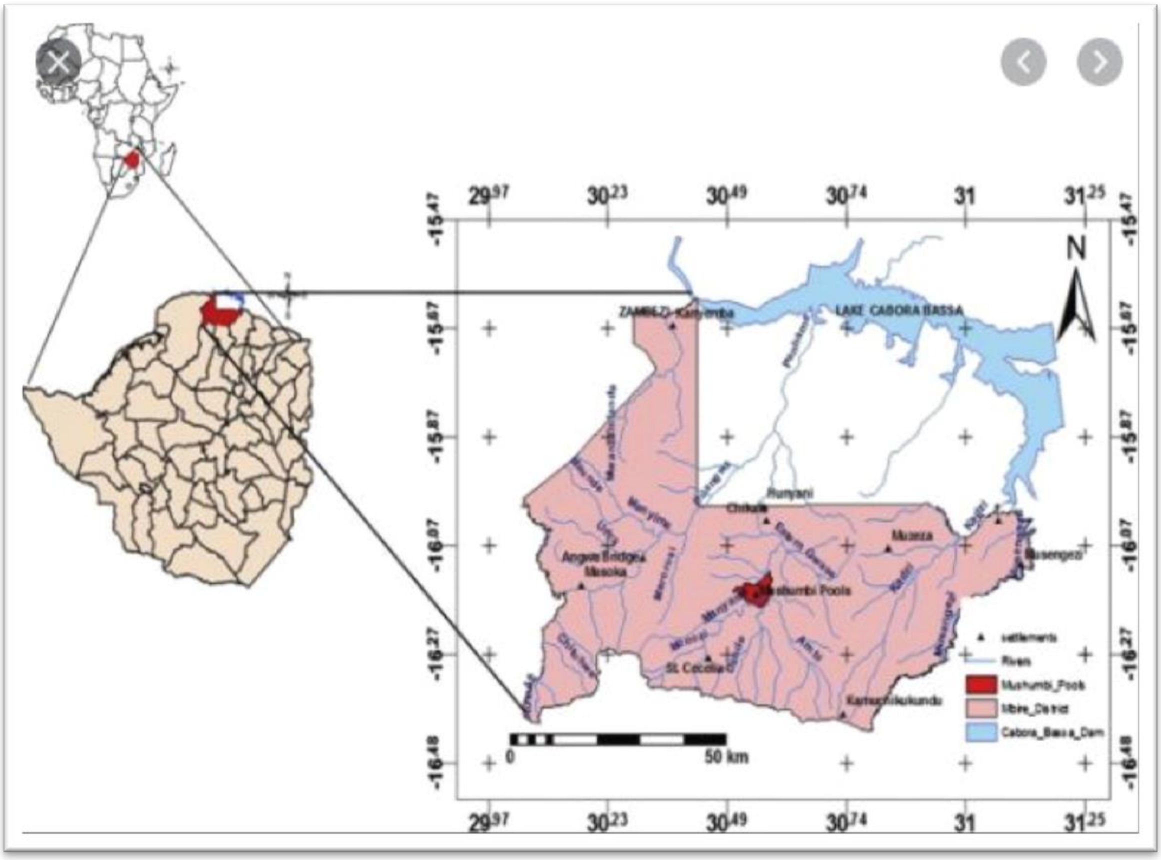

Figure 1:Geographical location of Mbire district.

Seasonal performance does not vary much over years and its characteristic long dry spell normally beginning December into January that result in poor crop establishment and repeated replanting. Mid-season dry spells are also common for up to 28 days from mid-January to mid-February severely affecting most crops at reproductive stage. Cereal sufficiency in Mbire has always been 4-6 months (2nd Round Crop and Livestock assessment, 2019).

At national level the 2018/19 production season had a shortfall of over 800,000 MT which had to be imported in the 2019/2020 marketing season to meet the country's human and livestock requirements. Thus about 59% of the total population was estimated to require food distribution between January to March 2020. (ZIMVAC report, 2019).

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The ZRBF programme has been implemented in Mbire by the Zambezi Valley Alliance in partnership with UNDP since 2016 to date. This project seeks to build community resilience in Mbire district through enhancing capacities, access to resources and opportunities to improve their well-being. The project was implemented for more than 3 years in the district and was funded by UNDP and supported by GoZ, through MAMID. The ZVA Consortium implemented the project in all 17 wards of the district. The project had 3 result outcomes which seek to improve the absorptive, adaptive and transformative capacities of the at-risk communities. The total number reached by the project is 16 714 households translating to 69 505 individual beneficiaries using an average household size of 5.

The main aim of this review was to investigate, and document trends analysis of sorghum production as being promoted under the ZRBF program to ascertain its potential for resilience building in Mbire. Yearly production comparisons were performed from 2016 to 2020 under ZRBF interventions to the 2015 baseline year.

During the last five seasons, various interventions have been promoted that supported small grains production under the ZRBF programme with the aim of increasing sorghum production in Mbire district. This study aimed to tress these individual interventions or in combination and analysis of the subsequent trends and ultimate contribution to increased sorghum production in Mbire district. It focused specifically on a defined promotion intervention, hectarage under sorghum, accompanying yields and ultimate production in tones over a period of five years.

Secondary data and desk reviews were conducted in close collaboration with Agritex and ZRBF/ZVA programme. National surveys and assessments data were also used to make inferences and triangulation of data and information.

Statistical testing was performed to investigate on significant differences and descriptive statistics such as means, mode and median were used in the analysis.

2.2 Food Shortage Crisis Trends

Contextual food insecurity proportions are illustrated in the figure below for Mbire district. This analysis gave pointers to contribution of sorghum production to food security if it is read in reference to figure 3.

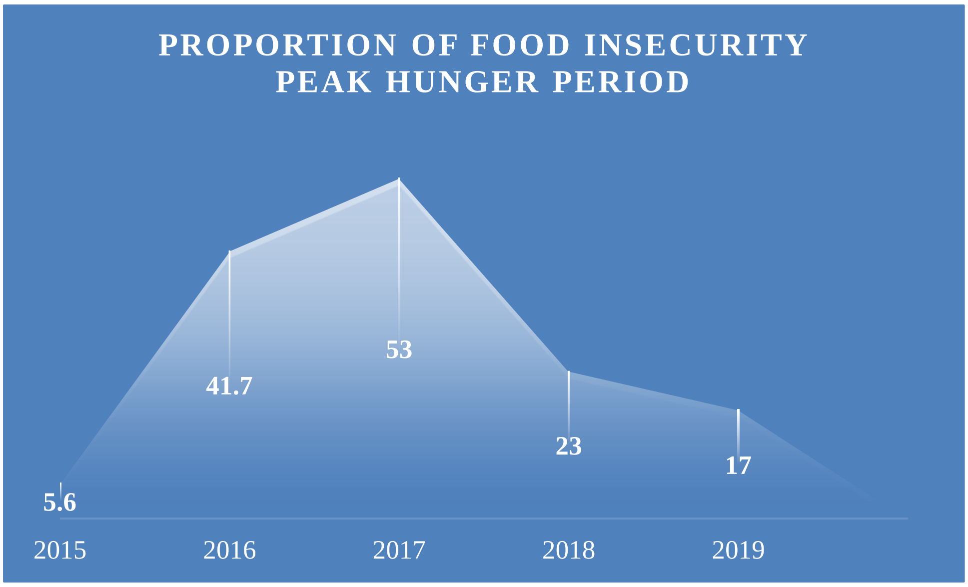

Figure 2: Proportion of food insecurity during peak hunger periods

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Descriptive statistics	
Mean	26.92
Standard Error	8.86264069
Median	23
Mode	#N/A
Standard Deviation	19.81746704
Sample Variance	392.732
Kurtosis	-1.854267334
Skewness	0.399252959
Range	47.4
Minimum	5.6
Maximum	53

Food insecurity was high in 2016 and 2017 which had 41.7% and 53% respectively. The highest proportion was recorded in 2017 although the preceding 2016 received the highest rainfall. The high rainfall received caused flooding and pest infestation that resulted in reduced cereal production and increased food insecurity in the following 2017 marketing year. The steepest fall was experienced in 2018 where 23% was recorded from 53% in the previous year. The continued to fall in 2019 corresponded to the increase in sorghum production as illustrated in figure 2. Steep rise in food insecurity from baseline scenario in 2015 through 2016 to 2017 can be attributed to progressive failure of maize production levels to ensure food security. Upon realization of these events by farmers with support from government and NGOs, farmers reduced area planted under maize and gradually increased area under sorghum. This was matched by corresponding continued increase in sorghum production (Figure2) and reduction in proportion of food insecurity from 2017 onwards.

2.3 Farm sizes and crop allotment

Farm sizes in this study referred to the average total area that was owned and put under crop production by an average household of five family members. Average farm size in Mbire district was 4.8 Ha under the 1992 Zambezi Valley / Derude resettlement scheme in a communal set up. There was no population pressure on land and on average, households grew sorghum on 1.5 ha. The low hectarage reflected seasonal shortage of labor and inputs. On average, slightly less (0.5ha) area was put under maize for those that grew maize along major river flood plains natively referred to as ‘Gowa” where they leveraged on the alluvial deposits and all year-round moisture. Cotton was grown on averagely bigger area (2 ha) since the 1980s as it was the only cash crop in the Zambezi Valley back then.

2.4 ZRBF Sorghum Interventions

Resilience building under ZRBF centered much on layering, sequencing and integration of interventions. Practical in field learning continuously informed the kind of interventions that were rendered to rights holders with the aim to protect developmental gains. Considering climate change effects, the ZRBF program supported government efforts on the promotion of adoption of traditional grains. Figure 3 below illustrates how sorghum promotion activities varied as they were layered on, sequenced and integrated with other interventions over the program years under study.

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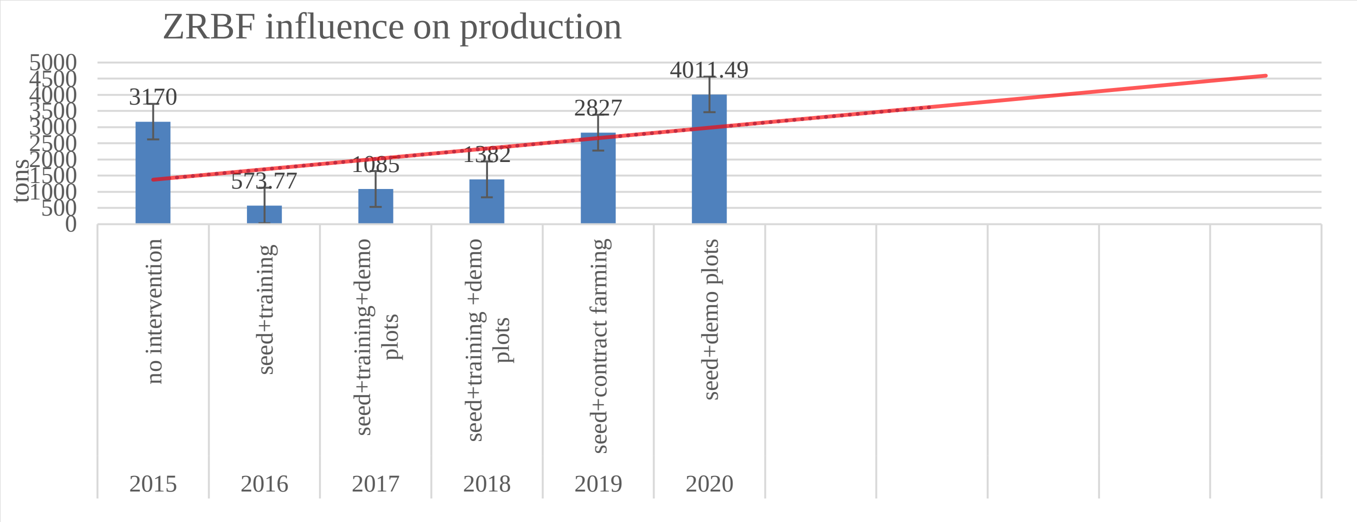

Figure 3: ZRBF sorghum interventions influencing production.

ZRBF varied intervention support on sorghum production from 2016 through to 2020. As intervention support was being improved from learning, significant increase in sorghum production was evident. In 2016 ZRBF supported farmers with sorghum seed and training and only 573.77 tons of sorghum were produced. After learning, support was upgraded to seed +training + demonstration plots and production increased by 89.1% in 2017. The steepest increase (104.55%) was recorded in 2019 where in addition to seed and training, contract farming negotiations were entered into with Delta. This indicated that market availability influence production of sorghum in these communities. Forecasted production for 5 years was a positive increase by 41.5% Figure 3. This indicated that sorghum will play an important role in food security as farmers are adopting the crop.

2.5 Nutrition

Sorghum is high in carbohydrates as well as proteins and dietary fibre although these are slowly digestible as compared to other cereals thus making sorghum beneficial to diabetics. Micro-nutrients include high levels of iron (>4070ppm) and zinc(>50ppm) both which help reduce stunting.

Table 1: Typical nutrient values for sorghum and maize

Nutrient	Sorghum	Maize
Protein (%Nx6.25)	11.6	9.42
Carbohydrate %	77	74
Fat (%)	3.4	4.7
Dietary fibre (%)	9.1-11.5	7.3
Ash (%)	1.6	12
Calcium(mg/100g)	29	7
Iron(mg/100g)	4.5	2.7
Energy (KJ/100g)	1374	365
Vitamin A (ug retinol equivalent)	11	11
Lysine (g/100g protein)	2	0.4

Source: Taylor and Emmambux (2007).

Sorghum has more protein than maize and the same is true for carbohydrates suggesting that sorghum can equally serve as a staple and failure to do that was merely due to individual preferences and taste. Probably preparation and processing of food end products could be another factor contributing to slow adoption by farmers. If these hinderances can be addressed, then sorghum may play a significant role in mitigating food insecurity in the semi- arid communal areas.

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2.6 Dominance of Maize

Globally, climate change effects started being experienced as early as around the 1960s. Western developed countries formed the IPCC in 1988 to provide that is dedicated to providing the world with objective, scientific information relevant to understanding the scientific basis of the risk of human-induced climate change, its natural, political, and economic impacts and risks, and possible response options. Developing African countries delayed engaging in mitigation measures. This resulted in continued growing of maize crop in Zimbabwe in the pretext that it was a staple crop albeit yearly crop failures due to successive droughts. Another reason that emanated from the above was that little research work was put on traditional grains. No varietal improvements and or breeding were done back then against pest and diseases to boost sorghum productivity. For the few farmers that grew the crop, over reliance on native long season varieties was the greatest challenged that was then even worsened by advent of climate change effects. Closely coupled to the above, was the fact that farmer incentives for producing sorghum did not come anywhere near the competing maize crop and that negatively affected market supply. However, all the above explained scenario was destined to changed when EL Nino and Cyclone induced droughts started recurring in the 21st century seriously rendering maize production inevitably non profitable especially in the Southern African countries including Zimbabwe. Production of drought resistant traditional grains was then advocated by central governments and non-state actors basing on their inherent drought and heat tolerant capabilities. In addition, the fact that sorghum's typical nutrition status also matched the initially preferred maize crop propelled it to be the best next alternative in the advent of the above described hazards.

2.7 Why Did maize dominate sorghum in Zimbabwe?

Literature review reveal a decline in area planted to sorghum until the 1980s. To understand this decline, secondary data and literature was gathered but no statistical analysis was performed. Therefore, a summary of the findings and general conclusions are summarized in this section.

In Zimbabwe at large, between 1974 and 1985 area planted to maize grew from 44% to 59% of the total area while area planted to sorghum and other small grains fell from 33% to 19%. The area planted to sorghum and millet was determined by the previous maize harvest. In drought years when maize failed, households ate their sorghum stocks then planted more in the following year to build up their stocks again. Two factors explain the decline of area planted to sorghum: the expansion of cultivation onto heavier soils more suitable for maize and the easy of pounding maize. In the absence of sorghum de-hullers, under normal year where women were responsible for feeding the family, were always encouraged to replace sorghum which required hand pounding, with maize which was processed by commercially operated hammer mills. *(Orr, Mwena and Nedumaran,2016).*

From around 1987 farmers grew a combination of short seasoned hybrid maize and sorghum. Maize was popular for following reasons. First, in average years, maize yields were higher by 30%. Although sorghum had higher prices and thus higher gross margin and returns to labour, that did not compensate for lower yields. Secondly, milling was easier. Whilst it took more time to pound maize by hand than sorghum, this was offset by availability of hammer mills that processed maize. Sorghum could also be processed by hammer mills, but the husks made the product rough and tasteless. Thirdly, taste preferences with most communities preferring porridge from maize. Finally, market regulations restricted the sale of staple food to maize meal.

Conclusions

- Farmers preferred maize for earlier maturity and higher yields. Any crop that shortened hunger period before the next harvest was a welcome innovation. *(Bender, 2011).*
- Farmers preferred maize because it could be processed by mechanical mills rather than being pounded by hand. This reduced drudgery by women.
- Maize was associated with modernity. Post-independence governments promoted maze to transform traditional agriculture into image that matched their future vision. High maize yields also promised national food security, which increased political legitimacy.
- Farmers in the semi- arid areas became 'locked' into the production of maize as they lacked alternative cash crops and feared sudden increase in maize prices that threaten household food security.

  In combination these factors explain why food deficit, risk-averse farmers in the semi-arid are willing to grow a staple crop that is less resistant to drought. However, farmers continue to grow sorghum because it provides food security when maize fails, because they prefer the taste and because when processed into beer, it provides women with a source of cash income.

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3. SORGHUM FACTS AND TRENDS

3.1 Overview

3.2 Trends in area planted under sorghum and maize

As at 2018/19 the total area under sorghum at provincial level increased from 23 208 ha to 31002 ha. (ZIMVAC,2019). Sorghum production was affected both by abiotic and biotic constraints that include numerous pests and diseases, low soil fertility and water stress. More efforts by farmers and non-state players were channeled towards improving sorghum productivity considering the above factors.

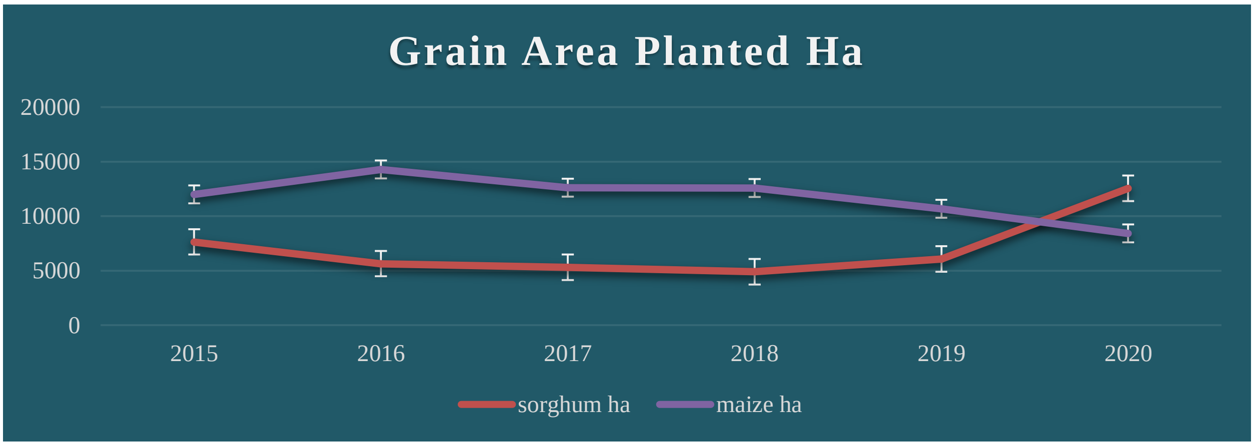

Figure 4: Area planted under maize and sorghum

The area planted under sorghum increased from 5648.3 tons in 2016 up to 12551 in 2020. This is matched inversely by a decrease in maize hectarage in the same period with corresponding decline in maize total production. Various interventions by government and NGOs were being promoted considering climate change effects thereby unlocking the potential of sorghum to provide for food security. This represented a scenario where sorghum was gradually replacing maize in the semi-arid areas thereby presenting a promising contribution towards food security. (Agritex, Mbire District data 2020).

3.3 Trends in yield of sorghum

Over the five-year period 2015-2020, the average yield was 0.3tons/ha. Generally, there trend was positive increase with some provincial figures in 2017/18 and 2018/19 representing an increase by 34% from 0.3 t/ha and 0.5 tons /ha. Whilst rainfall normally direct affected yield for a given year, a strange scenario was observed in 2016 where received rainfall was highest (1028.8 mm) and corresponding lowest yield (0.1ton/ha) for the period under study, Figure: 4. The reason was that quelea bird infestation was reported thereby demonstrating how other natural disasters affect yield and subsequent food security. From this scenario, this prompted promotion of varieties that were not susceptible to quelea birds such as ‘Shirikure’ and other practices as early planting that would allow farmers to escape such.

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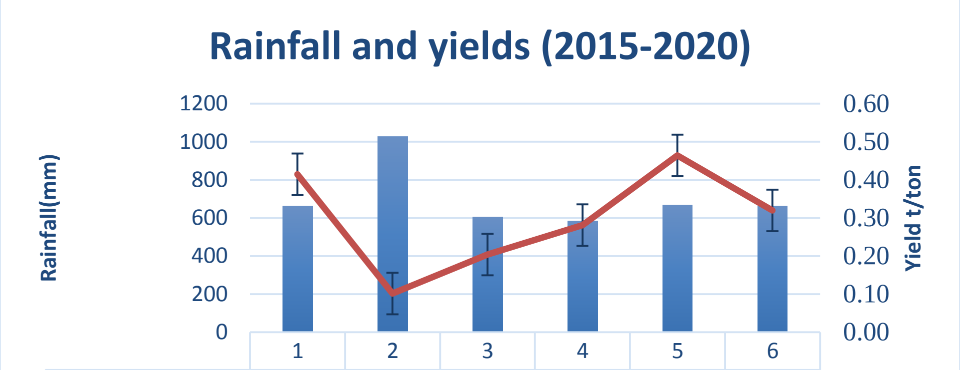

	1	2	3	4	5	6
mm	663.1	1028.8	605.7	585.2	669.4	661.9
t/ha sorghum	0.41	0.10	0.20	0.28	0.46	0.32

Figure 5: Annual rainfall and corresponding yields of sorghum.

Thereafter, a gradual positive increase in yields was recorded even with little variability in total amount of rainfall received. This was attributed to improved agronomic practices on sorghum production as promoted by government and NGOs. Such practices include adoption of improved varieties, increased investment in agricultural research, climate smart agriculture and creation of economic incentives. With such positive response over the years, sorghum thus becomes a potential crop for food security in the semi -arid areas. However, the low yield potential of sorghum remained a cause of concern that need to be addressed if production was to be extended beyond subsistence. This also applied for utilization of sorghum where more end products or uses of the crop were to be identified to stimulate persuasion of the full value chain on a profit- making business model. This is discussed more under the utilization section of this paper.

The box below illustrates why it is generally said that sorghum has low yield potential. It also illustrates the existence of gaps in terms of the current yield potential and the maximum that can be realized under certain optimum conditions cognisant of the law of diminishing returns.

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Box 1: Why are sorghum yields so low?

Although the average yield increased from 2016 to 2019 Figure 4, the yields remained low according to national standards. Household survey data from top 5 producers under ZRBF program revealed 0.8t/ha.

Table 2: Sorghum Yield Gaps (t/ha)

Year	ZRBF top 5 farmers average (t/ha)	The rest (t/ha)	Yield gap (%)
2016	0.2	0.1	100
2017	0.35	0.2	75
2018	0.5	0.28	79
2019	0.9	0.46	96
2020	0.7	0.32	119
Mean	0.53	0.27	
t Critical (two tail)	2.77		

Sources: ZRBF Program Reports, 2018

Information in table 1 above shows that average yield gap was 94% above the between top 5 farmers and the rest. Possible explanations for the gaps could be: **Limited adoption of improved varieties and crop management practices.** Sorghum growers generally used traditional varieties and management practices in contrast to maize where improved varieties were widely adopted. Similarly, farmers did not use organic fertilizer for sorghum. **Under investment in agriculture research for sorghum.** This has led to limited supply of improved sorghum varieties. **Lack of economic incentives:** Low market demand was also another reason since farmers would always want to invest in crops that they would sell. In conclusion, the large gap between average and potential yields demonstrates the scope for raising sorghum yields under dry land farmers' field conditions thereby qualifying it to be the best alternative to maize for food security.

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3.4 Variability in Area Planted ad Production

The figure below illustrate variability in sorghum and maize production over the period under review. This help give a general overview of the adoption of sorghum over the traditional maize.

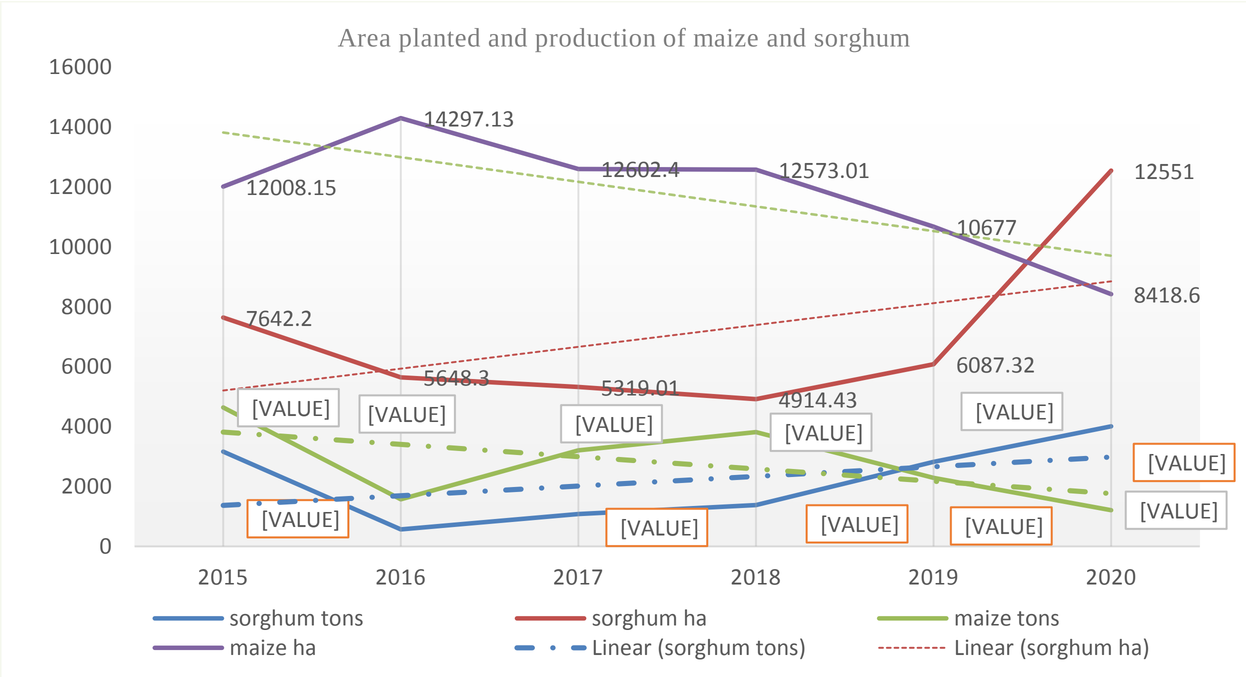

Figure 6: Area planted and production of maize and sorghum.

The graph line for hectares planted with sorghum showed a gradual increase from 5648.3 hectares in 2016 to 12551 hectares in 2020 Figure 6. A corresponding gradual increase in tones produced was also revealed from 573.77tones in 2016 to 4011.49 tons in 2020. Maize production declined with a decrease in area put under maize during the same period. As hectarage under maize declined from 14297.13 hectares in 2016 to 8418.6 hectares in 2020, a corresponding decrease in production was eminent from 1577.09 tons to 1214.24 tons in the same years. These trends were attributed to various factors but chief among them were government, NGO and private sector promotion and advocacy on sorghum production rather than maize for increased food security in the semi -arid areas. Figure 3 supported the above explanation whilst Figure 2 illustrated the positive impact of such interventions in terms of reducing proportion of the food insecure populations over the period under study.

3.5 Individual grain contribution to total available grain

The percentage contribution by crop as illustrated in Figure 7 below showed an increase in contribution by sorghum and the inverse was correct for maize. The steepest increase in sorghum production was between 2018 where it contributed about 30% and 2020 where it contributed about 88%. This was matched by Figure 2 illustration of the steepest decrease in proportion of food insecure populations from 53% to below 17% suggesting that sorghum played a pivotal role in food security in the semi-arid areas where maize production was always negatively impacted by little rainfall.

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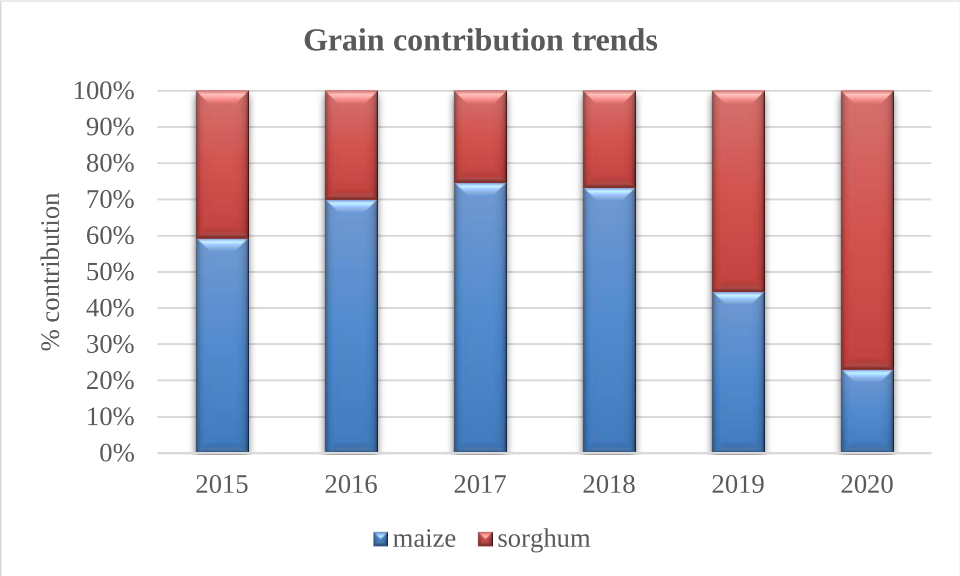

Figure 7: Sorghum and maize contribution to total available grain.

The fact that the food insecurity population percentages decreased in the same years when sorghum contribution to available grain increased reflected that sorghum had the potential to increase food security in the semi-arid areas. However, more efforts were recommended in terms of incentivizing sorghum production, research and extension work and varietal improvements.

3.6 Sorghum Utilisation

Sorghum has a wide variety of uses in communal areas. Whole grain is eaten after boiling flour into 'sadza' and is also used for brewing alcoholic and non-alcoholic beverages. I was revealed that one characteristic that made it suitable for beverages is the low tannin content producing a taste that is preferred by most consumers.

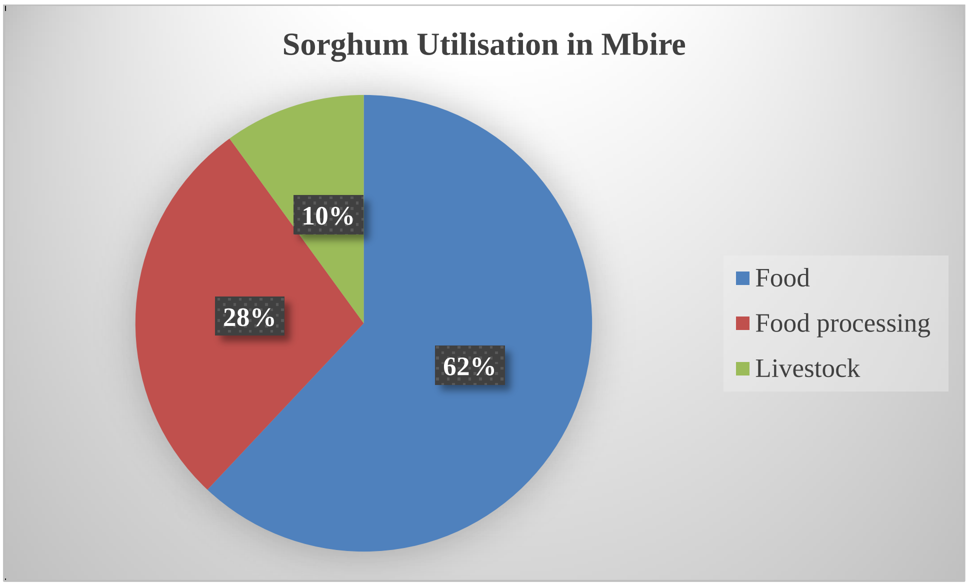

Figure 8:Sorghum Utilisation allotment

Food and food processing represent the major uses of sorghum 62% and 28% respectively. Although sorghum grain was not normally fed to livestock, stover was used for fodder as well as fuel and for building and roofing houses. As more effort was being put towards production of sorghum for household food security and resilience, more food and non-food end products need to be identified for industrialization of sorghum. Mass production and localized mass consumption was recommended to commercialization of sorghum after mitigation of food insecurity in these semi-arid regions.

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3.7 Sorghum Market Prices

Table below illustrates incentives for sorghum under the period of study. Inflation affected the economy of Zimbabwe so much that prices and buying arrangements kept on changing on yearly basis. Table 3 below illustrated how sorghum was being traded with GMB and Delta as the main players on the local market. No formal free export trade was recorded probably due to low production of sorghum for the period under study.

Table 3:Producer Price trends

Year	USD	RTGS
2015	245	Official rate could not be ascertained
2016	250	Official rate could not be ascertained
2017	290	Official rate could not be ascertained
2018	290	Official rate could not be ascertained
2019	Official rate could not be ascertained	$2 400-00
2020	Official rate could not be ascertained	$16 726-00

The price per metric ton varied over the years both in terms of the amount and currency method. The economic situation in Zimbabwe saw the country changing from using the multi -currency system through to the bond to the RTGS system. This has caused serious distortions in terms currency stability and as such analysis of the producer prices was not performed to establish trends. However, was safely generalized that the producer prices revolved on an average of $250 USD per metric ton for both maize and sorghum and ranged between $USD 240-USD 290 during the period under study. (GMB figures,2020).

3.8 Markets, Institutions and Policies

Zimbabwe was a member of the Common Market for Eastern and Southern Africa (COMESA) and thus qualified to be in the Eastern and Southern Africa (ESA)free trade area. However, in practice it had its own policies for staple food grains that include tariffs, imports and export bans and price support. (Kilambya and Witwer 2013). The below policy was operational in Zimbabwe during period under review. Zimbabwe imposed import duty in order to protect local producers. High world food prices could see suspension or reduction of import tariffs for food products and subsidized food prices. In response to high inflation and food shortages, export of food could be banned. These policies could be applied by Zimbabwe as directed by the status core of food insecurity. However, one result from such policy set up could be the gap between world market and what the actual farmer gets. The size of this gap was calculated as the National Rate of Protection (NRP), which compared domestic market prices to reference market free from domestic policy interventions. Reference prices were calculated from benchmark price, such as an import or export price expressed in local currency, that would then be converted to wholesale or farmgate price by adjusting for quality, wastage and the cost of market access. This NRP expressed as a ratio, represented a price gap between domestic market price and the reference price divided by reference price. A positive NRP indicated that farmers enjoyed the price advantage over imports and exports, while a negative NRP indicates that farmers face a price disadvantage. (Angelucci et al,2014). It was highly recommended that these calculation and policy implementation be seriously considered if sorghum production was going to be beyond subsistence for food security and towards industrialized commercial production.

4.0 CONCLUSIONS

There was a general perception that sorghum production was in terminal decline in Zimbabwe. Whilst this may have been true for the country at large, regional differences existed. This review of the past trends for sorghum production in Mbire from 2015 to 2020 revealed a more positive scenario for the district. Since 2016 production has been on the increase with a positive projected increase of 4500 tons in the year 2025.

Mbire had a different trend from that of the country because, being a good example of a semi -arid region, rising demand for sorghum was primarily driven by consecutive droughts that hindered staple maize production. Unlike other regions that received adequate rainfall, demand for sorghum in Mbire was not driven by the coming up of new uses such for poultry and livestock feed,

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but rather for food (flour and beverage brewing) whose demand for this was also growing. In the short and medium-term demand, would primarily be for home consumption by these communities.

Previously, sorghum seemed to compete with maize and was true in the past when government supported maize after independence as a staple grain for national food security. However, with the dawning of climate change sorghum was now grown in areas where farmers could not rely solely on maize for household food security primarily because of inadequate total rainfall, its distribution and the dry spells that followed thereafter. In such above situation sorghum exhibited drought and heat tolerant characteristics that allowed it to yield significantly high and complimented maize in enhancing food security at household level.

In terms of markets and incentives, sorghum previously was out competed by maize but due to its promotion by government (Agriculture Recovery Plan) and NGOs (ZRBF program) in Zimbabwe, the incentives have relatively been higher than those for maize for the past five years. This reflected supply shortages due to low production and their contribution to household food security that reduced amount being channeled onto the market.

Rising yields of sorghum increased farmers' ability to meet growing demand. Currently, yield increased slowly over years and most growth in production was attributed to increased hectarage planted. Yield gaps between farmers under ZRBF interventions and conventional farmers indicated that there was potential to raise average yields thus high production. High investment in research and development of new varieties was recommended as key in improving the supply of such new varieties. However, higher yields will not require just improved varieties, good soil management and crop management. Rather, policy implications also must be considered in line with sorghum production and subsequent trade that incentivise production of small grains starting at individual household to national level. A step ahead to investigate opportunities for international trade of sorghum after increased production versus production for national food security were cited as issues that can be crafted in policies such as food policies and recovery plans.

Projections suggested that by 2025, production of sorghum will increase by more than 10% from 2020 production. However, this will need to be supported by continued investment in research and development for new high yielding varieties, soil and crop management practices. This will allow sorghum to remain an important food crop in Zimbabwe specifically in drought prone semi-arid regions where household food security cannot solely depend on maize. Its tolerance to heat and drought will increase its importance as a source of adaptation to climate change. Higher yields will increase its potential to contribute into international trade. These are powerful points on relevance of sorghum in food crisis mitigation for smallholder communal farmers in semi-arid areas in Zimbabwe. These justify the need for continued investment in research and development of new varieties of sorghum, improved soil (Organic carbon) management and crop (agronomy) management for maximum productivity.

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