Potential Blue Zone Status of the Dryland Area of Buhera District in Zimbabwe: Development of a Hypothesis

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Abstract Science has shown that the damage to our DNA happens especially because of the lack of micronutrients such as minerals caused by eating devitalised food hence the existence of low life expectancy in most of Africa. This hypothesis suggests that inspite of the Buhera district being in the agro-ecological region V of Zimbabwe which is a dryland region; the people in that area seem to live the longest when compared to the rest of the country. It is postulated here that this might be because of the practice of dryland agriculture in certain sections of Buhera South where dryland traditional crops and grains such as sorghum, millet and Bambara nuts are grown and consumed. Additionally, the people in the region have adapted to the consumption of drought resistant traditional fruits such as baobab and marula which are endemic to that region. Observational studies and informal discussions with some residents of Buhera conducted over a period of five years suggest that the longevity of residents could be influenced by the consumption of a traditional diet of these nutrient dense traditional foods. This hypothesis awaits systematic study and validation of all the parameters which contribute to a region being labelled a blue zone. This subject is important to implement health reforms, combat diseases, and improve quality of life of the people.

Keywords Blue zone · Dry region · Millets · Sorghum · Buhera · Quality life · Health reform

Introduction

Zimbabwe is a semi-arid country (Government of Zimbabwe 1998) comprising some regions which are drier than others and as such has been divided into five agro-ecological regions of I–V, with the later receiving the least rainfall (Chikodzi et al.

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2013). About 41% of the world's landmass is covered by drylands which feed an estimated 2 billion people (Solh and Van Ginkel 2014).

Buhera located in the eastern part of Zimbabwe is the largest district in the country and is classified in the Natural Regions III, IV and V (Mvumi et al. 1998) with temperatures reaching as high as 40 °C and annual rainfall between 400 and 600 mm (Lindahl and Matenga 1995). It is a dryland region where drought tolerant crops such as pearl millet *(Pennisetum glaucum),* finger millet *(Eleusine coracana L.),* sorghum (Sorghum bivulgare) and Bambara (*Vigna subterranea* (L.) Verdc.) nuts have been successfully cultivated as a mitigation strategy against droughts and climate change (Wood et al. 1996) compared to other food crops such as maize *(Zea mays* L.) which are less drought tolerant.

Indigenous fruits found in this region include baobab *(Adansonia digitata L), m*arula *(Sclerocarya birrea)* and African Snot apple (*Azanza garckeana*) tree which have been successfully adapted for diet and other non-food uses such as traditional medicines and production of commercial household artefacts like mats (Kozanayi 2018). Concomitantly it has been observed that some residents of Buhera seem to live a longer life, with a recorded case of 107 years. Research on the topic of blue zones, the areas of the world where people live the longest suggests that 80% of a person's longevity of life is influenced by their lifestyle and environmental factors than their genetic make-up (Buettner and Skemp 2016) as also revealed by a Danish Twin Study (Herskind et al. 1996). Lifestyle medicine which includes the use of a correct diet has been touted as the next frontier for treatments of disease and improving human health (Bodai et al. 2017).

In this context, a preliminary investigation was carried out to understand the phenomenon of the unusual longevity of life in the Buhera district of Zimbabwe in the counter-intuitive background of Buhera being a poor and a dryland region compounded by Zimbabwe being classified as one of the low income countries in the world (Celik et al. 2019). The reliance of the residents of Buhera on small grains from crops which are drought tolerant in an arid and semi-arid environments, wild indigenous fruits and indigenous leafy green vegetables which are endemic to the regions and have a micronutrient-dense profile is suggested as one of the reasons for a possible blue zone phenomenon in this region.

Literature Review

Climate Change Adaptability

The people who live in the arid and semi-arid regions of Zimbabwe and depend on rainfed agriculture have recognised the adverse phenomenon of climate change and variability prompting active responses to mitigate against these events (Bhatasara 2015). There is also consensus that sub-Sahara Africa is increasingly more impacted by climate change because of reduced capacity for mitigation due to poverty and poor

governance systems among other constraints (Manyani 2017). Buhera is considered as one of the poorest districts of the country excercebated by the unfavorable climatic conditions which have prompted some development agencies to seek ways for on-going active involvement in the region beyond just providing food aid. (Mafuta and Kamuzhanje 2020).

A range of mitigation strategies have been demostrated to work globally for improving livelihoods in dryland areas especially as these regions are impacted upon by the effects of climate change (Kumar et al. 2019). Methods for mitigation which include *in-situ* water harvesting have been practiced in dryland areas such as Gwanda in Zimbabwe (Munamati et al. 2009). A myriad of coping mechanisms practiced in other regions of Zimbabwe include cultivating drought tolerant crops coupled with diversification, and consumption of cereals and endemic wild fruits (Campbell 1987) within dryland regions such as Zambezi valley (Mavhura et al. 2015). Investigations have also revealed that the use of organic manures, inorganic fertilizers and crop rotation with leguminous crops followed by sorghum can help improve the yields for the small grain crops (Ncube 2007). In Malawi for instance, the baobab fruit, a dryland fruit tree has been used as a supplemenary food during periods of scarcity (Darr et al. 2020), whilst in the lowveld south east of Zimbabwe, another arid part of the country, the processing of baobab fruits, leaves and fibre has been used to combat the effects of poverty (Mugangavari 2019).

Ironically, in some dryland parts of Zimbabwe, the communities worst affected by climate change have shifted to the cultivation of crops such as maize (Murungweni et al. 2016) while the communities in drought-prone regions like Mutoko have resorted to the cultivation of sorghum and millets along with practising adaptation strategies such as mulching, creating walls on river banks as well as better facilities for food storage (Mugambiwa 2018). Pearl millet is still largely grown in West Africa whilst maize has superseded the indigenous millets in Southern Africa because of the commercialization of maize (Azare et al. 2020).

Traditional Grains and Legume Cultivation

As a dryland region, Buhera is vulnerable to droughts which are becoming more frequent and thus affecting crop productivity (Mutasa 2010). The studies indicate that the region is among the top three districts in Zimbabwe with poor seasonal vegetation health index and an average of 6.84 drought events over the past 30 years (Frischen et al. 2020). Women are particularly affected in the district compounding a *status-quo* of poverty and prevalence of obstacles for livelihoods in a country where most subsistence farming is practiced by women (Maruzani 2014).

Millets are indigenous to Africa and have a better adaptability for arid and semi-arid regions with pearl millet now considered as the 6th most important grain globally (Garí 2002). These crops have been demonstrated to improve food security in Buhera and other dryland regions of Zimbabwe such as Mangwe in Matebeleland South (Muzerengi and Tirivangasi 2019). The profile of the crops which are grown in the

Manicaland province where all the natural ecological regions from I to V are found is given in Fig. 1 below (Chingarande et al. 2020). The dryland districts in this province are Buhera and Chipinge. There is a propensity by the dryland regions to grow sorghum, millet and cowpea all of which are drought tolerant crops. Whilst it has been shown that climate change is affecting the growth of crops such as maize, a preferred staple in Zimbabwe (Makadho 1996), sorghum and millet offer better alternatives because of their resilience to drought risk (Mukarumbwa and Mushunje 2010). In another study, Chikodzi notes that groundnuts followed by sorghum and lastly maize are least sensitive to climate variability which explains why there is preference for the small grains in Buhera (Chikodzi 2016). Other leguminous varieties such as cowpeas are also preferred in Buhera with higher tonnage in this district compared to the wetter districts of Chimanimani, Makoni, Mutasa and Nyanga which are in region I, II and III (Fig. 1). This is because cowpeas also have the capacity and ability to grow in challenging climatic conditions of water shortage coupled with sandy soils (Nkomo et al. 2020). The distribution of tonnage of the grains grown and harvested in Buhera: Whilst maize constitutes about 51% of the grain probably cultivated in the region III part of Buhera, the small grains and drought resistant legumes remain an important component for militating against the extreme climate conditions for regions IV and V of Buhera district (Fig. 2).

Bambara nuts (*Vigna subterranea* (L.) Verdc.) which originated in West Africa have also become a common cash crop in semi-arid regions of Africa including Zimbabwe because of its resistance to moisture compared to even sorghum another dryland crop (Hillocks et al. 2012). Villagers in the semi-arid Buhera have as such

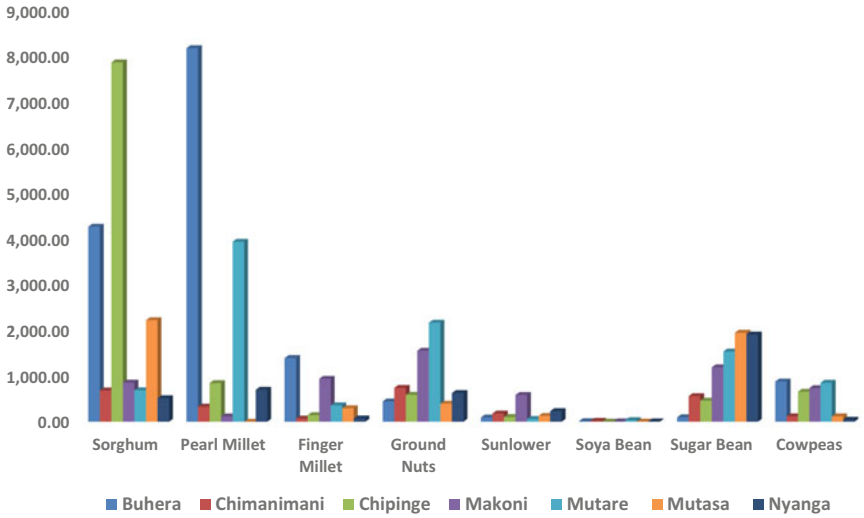

Fig. 1 Tonnage of harvested crops in 7 districts of Manicaland province where Buhera is located (original data obtained from USAID) (Chingarande et al. 2020)

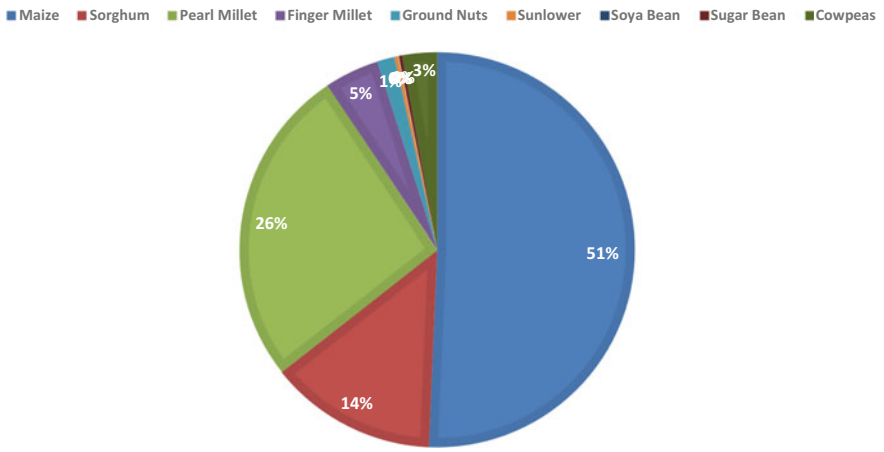

Fig. 2 The proportion of grain crops which were harvested in 2019 cropping season in Buhera (original data obtained from USAID) (Chingarande et al. 2020)

also resorted to the cultivation of Bambara nuts for its nutritive value where other sources of protein are low (Mubaiwa et al. 2018).

Though pearl millet, finger millet and sorghum are the crops which are grown successfully under rainfed in Buhera (Lindahl and Matenga 1995), there is a resistance by smallholder farmers for cultivation of these crops due to the perception that these crops need high labour, vulnerable to bird pests such as quelea (Phiri et al. 2019).

The Use of Green Leafy Vegetables

Studies reveal that 92% damage to our DNA happens especially because of the lack of micronutrients such as minerals caused by eating devitalised food (Ames 2006) and the lack of consumption of leafy greens (Amazing Discoveries and O'Neill 2017) and hence the existence of low life expectancy in most of Africa and in other regions of the world. About 40 micronutrients are required by the human body, deficiency of which may lead to DNA damage which triggers chronic disease (Ames 2001). For instance selenium as a nutrient is needed for DNA repair (Bera et al. 2013) and as such strong associations (Tang et al. 2008) have been established between the pathogenesis of diseases, morbidity and mortality, and the inclusion or lack thereof of vegetables and fruits in diet (Collins et al. 2012). These articles of food which are micronutrients and mineral dense. Minerals are important for several structural and physiological functions (Soetan et al. 2010) in the human body particularly to prevent chronic conditions such as cancer. The residents of Buhera are known to supplement their diet with the consumption of wildgreen leafy vegetables from such

plants as cat's whiskers *(Cleome gynandra)*, smooth pigweed *(Amaranthus hybridus)*, baobab *(Adansonia digitata),* black jack (*Bidens Pilosa*) which have been found to have a better nutritional content that the conventional non-indigenous varieties such as spinach and lettuce (Chipurura et al. 2013; Muchuweti et al. 2009). Villagers in Buhera are well versed in the processing of indigenous vegetables for sale to traders (Mukwereza 2002). The care should be taken not to overcook since it reduces the nutritional quality of these vegetables (Chipurura 2010).

Water Conservation Systems

Because of the erratic rainfall pattern in Buhera district, villagers have resorted to water harvesting techniques to the extent that 72.9% of water in Buhera is obtained from wells whilst boreholes constitute 21.6% where there is no canal water irrigation to support rain-fed agriculture (UNESCO & Ministry of Lands AgricultureWater and Rural Resettlement 2019). Farmers have also resorted to the use of shallow hoe-dug furrows for planting small grains like sorghum in Buhera without prior ripping and ploughing as a method to manage soil moisture content (Zimbabwe Conservation Agriculture Task Force 2009). In drylands of Chiredzi the yield of pearl millet increased from 1.67 to 3.29 t/ha, hence shift towards climate-smart agricultural practices in uplands and wetlands may be promoted (Murungweni et al. 2016). In collaboration with international agencies, the local people have been able to grow exotic vegetables such as kale and cabbage in trenches loaded with manure while the soil from the trenches was used to grow potatoes, beans and other legumes whilst making sure to use crop residues from other crops like maize and sorghum to retain moisture and for weed management (USAID 2017).

Bioprocessing

The processing of crops as an indigenous heritage in Buhera reveals how its citizens have adjusted to living in one of the hottest regions of Zimbabwe. For instance, Bambara nuts are not only grown as a cash-crop for local consumption and also export sales in Buhera. The residents have adapted this hard-to-cook legume (Mubaiwa 2018) for easy consumption by soaking and sometimes grinding and milling before cooking it into a snack used as replacement for starchy foods (Hillocks et al. 2012). The use of a rock salts called *gowa* sourced from Buhera including sodium hydrogen carbonate at an experimental level by some researchers suggest that such methods might have been practiced in Buhera (Mubaiwa et al. 2019).

The Use of Traditional Fruits

The additional advantage of Buhera district is that it is home to endemic species of indigenous fruit trees unique only to this region including the marula, baobab, snot apples, wild grapes among others (Shava and Garden 2005). Since many years, the residents from and around Buhera have used the ancient Baobab tree to make products such as salt-containers called *gumbu* (Kozanayi et al. 2014) and other non-food item including mats. The use of baobab which is indigenous to Africa (Rahul et al. 2015) includes exploitation of its dried fruit pulp and leaves in Buhera and this is partuclualy important as the fruit can be stored for a long time and as such an important source of nutrients such as potassium (Chipurura 2010) and vitamin C (Mpofu et al. 2014). *Mutandabota*, a local probiotic made out of baobab pulp contains milk up to 79% (Anita et al. 2014; Mpofu 2015; Mpofu et al. 2014, 2016) is also consumed in Buhera even though no documented work can be found concerning its bioprocessing and value addition practiced in Buhera.

The Marula (*Sclerocarya birrea* subsp. *caffra*) is a sub Saharan (Sinthumule and Mashau 2019) tree which is capable of surviving in the marginal areas such as Buhera has also been used as adaptation strategy by harvesting its fruits and non-edible parts. Although the research information on this in Buhera is not available, villagers are known to mix marula juice, baobab pulp and millet flower to prepare a fermented non-alcoholic beverage safe for consumption by pregnant mothers and children (Nyambiya 2020b). Residents in Buhera have subsisted on wild fruits such as Hanza (*Boscia senegalensis), Indian plum (Ziziphuis Mauritania), Jiga tree (Maerua crassifolia)* and the fresh fruits of Sugar plum (*Uapaca Kirkiana) which* have been known to supplement food reserves during the lean months in Buhera just before the onset of rains.

Potential Blue Zone Status

The informal observational studies seem to suggest a relatively longer longevity index for some residents in the Buhera district; this needs a systematic study of the demographics of the region, the food security analysis especially with regards to the consumptions of "small" or traditional grains and indigenous fruits upon which this hypothesis depends. The global burden of disease resulting in early mortality (Lopez et al. 2002) is directly correlated with lifestyles (Hurst and Siddharthan 2020) even now in Africa (Zumla et al. 2015) where statistics of lifestyle diseases such as obesity, heart disease and diabetes are increasing as in the rest of the world.

Five regions around the world have been designated as Blue Zones (Buettner & Skemp), meaning they possess the largest number of people who live the longest because of their lifestyle which forms part of the environmental factors that affect longevity of life (Poulain et al. 2004) and perhaps because of genetic factors. None of these regions are in Africa and to the best of the author's knowledge no suggestions

or systematic studies have been done where longevity factors have been observed. These areas are Loma Linda in California where the Seventh Day Adventists practice the eight laws of health (Kent 2017) particularly a plant based diet (Snowdon and Phillips 1985) to prevent disease (Fraser 1999; Girko 2016) and stay healthy from non-communicable diseases (Kim et al. 2018). The residents of Okinawa in Japan are known to live longer (Willcox et al. 2008) because of a life of good diet and calorific restriction (Willcox et al. 2007) a practice called temperance in health reform (White 1949). The studies in Nikoya in Costa Rica and Ogliastr in Sardina regions, Italy have revealed a largely plant-based diet as positively correlated with the phenomenon of longevity of life in both regions (Nieddu et al. 2020). The residents of Ikaria in Greece also live longer (Chrysohoou et al. 2011; Stefanadis 2011) because of a Mediterranean type of diet (Lăcătușu et al. 2019) besides other factors. Lifestyle medicine for managing health and disease is now slowly entering into the public domain globally (Bodai et al. 2017) and it has been demonstrated through the very recent field of epigenetics (Moosavi and Ardekani 2016) that environmental factors such as diet through methylation at the gene level influence the emergence of disease even in monozygotic twins who are identical at the gene sequence level (Esteller 2008).

Methodology

The methodology involves hypothesis development based on the scientific method of enquiry (McLelland 2006) leaning heavily on the definition of a hypothesis as "an idea or postulate that must be phrased as a statement of fact, so that it can be subjected to falsification…constructed in advance of the experiment" (Glass and Hall 2008). Observational studies over a period of about five years (Nyambiya 2020a) seem to suggest that there is a relatively larger population of people who live beyond 80 years in Buhera (Nyambiya 2020b) which is counter-intuitive given that Buhera is one of the driest regions in the country and they are regarded as poor. Additionally, it also appears that the larger proportion of these individuals are women.

Regions of the world such as Nikoya in Costa Rica have revealed a similar phenomenon of poverty negatively correlated with longevity of life giving credence to the hypothesis that it is not necessarily wealth that leads to long term health (Rosero-Bixby 2008; Rosero-Bixby and Dow 2016). The observations made at a farm at which the author lived for about four years seem to suggest that rodents such as the African rat when naturally feeding have a preference for the so-called superfoods (See Fig. 3) in the order of linseed, millet, soybean ending with non-superfoods such as sugar-bean and maize (Nyambiya 2019). As such any regions of the world where these foods are preferred in greater proportion could contribute to a greater longevity index as found in the regions already studied deriving from their own unique circumstances.

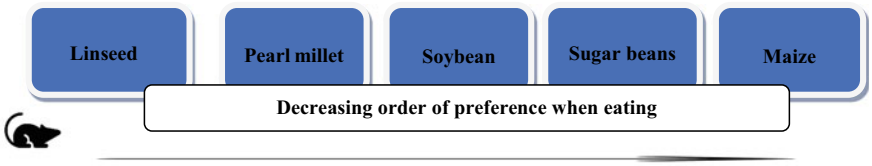

Fig. 3 Some feeding habits of the African rat

More animal studies can be performed to validate the claim for rodents having a "superior wisdom" of subsistence on crops which humans have chosen to have less regard for in spite of knowledge of their superior nutritional value.

The Hypothesis

This chapter proposes an hypothesis that there seems to be a larger proportion of Buheraeans living longer which could be their larger reliance on sorghum, pearl millet and finger millet as the staple food in their diet (Lindahl and Matenga 1995) given these crops' ability to thrive under hot and arid conditions (Padulosi et al. 2015) such as in Buhera (John Wood 2005). Millets are known to have good nutritional content which reduces oxidative stress or damage (Devi et al. 2014) the cause for premature aging. Research has demonstrated that foods like millets contain isoflavones including genistein (Russin et al., 2006) essential for reducing inflammation (Yu et al. 2016) associated with reactive oxygen species (ROS). The oxidative stress hypothesis posits that the continual loss of bodily and organ function and vitality due to the accumulation of ROS (Liguori et al. 2018) leads to disease and death which can be countered by a supply of antioxidants found in appropriate plant based-based diets (Madigan and Karhu 2018) from crops such as millets (Devi et al. 2014; A. Kumar et al. 2018; Nani et al. 2015; Saleh et al. 2013), linseed (Ayelign and Alemu 2016; Goyal et al. 2014; Kajla et al. 2015; Mishra 2013; Garnorka & Jain 2013) and polyphenol-containing soybean (Chao 2008; Radd 2000). In spite of the fact that Buhera is a poor semi-arid and arid region in Africa, the reliance of the population on indigenous crops and fruit trees seems confer better lifestyle attributes.

Discussion

The population in the dryland regions in Zimbabwe such as Beitbridge (Murungweni et al. 2016) Chiredzi, Muzarabani (Manyani 2017) Mutoko (Bhatasara 2015), Bulilimamangwe (Muzerengi and Tirivangasi 2019), the Wengezi and Gudyanga areas in the south-east lowveld of Zimbabwe (Mugangavari 2019) including Buhera (Chikodzi 2016) have adopted resilient strategies to combat the effects of climate

variability and climate change, and as such subsist on drought resistant crop varieties and indigenous fruit trees among other coping mechanism. Whilst maize has been consumed in Africa for over 500 years (Kodamaya et al. 2007) from its deemed origins in Mexican (Benz 2001), it remains a non-indigenous crop especially in Sub Saharan Africa to the detriment of the local populations especially as health reform recommends the consumption of foods which are native to a particular region for the benefit of the local populations (White 1905). Such diets have been known to boost the base immune system for the local people helping to fight disease (Akinola et al. 2020). For instance pearl millet has an iron content of 74.9% compared to the 20.0% for maize (Devi et al. 2014). Millets are known to contain selenium (Liu et al. 2016) an important antioxidant which prevents gene mutation (Ames 2001). It is in this respect it is proposed to carry put systematic studies into healthy lifestyle habits in the African regions for health reform.

The work suggested in this chapter awaits systematic and rigorous investigation and validation. It borrows heavily of various works which have already been undertaken on the current blue zones determining such parameters as spatial and longitudinal mortality patterns of the residents of Buhera over a determined period of time and cross-sectional comparison of biomarkers, diet and other health risk factors as has been studied elsewhere (Rosero-Bixby et al. 2014). Interesting statistics in the AKeA2 study have shown women living longer when they have fewer children with the last born coming at an advanced age (Lipsi et al. 2015). Already observations seem to suggest such a phenomenon in Buhera. The so called trait resilience has also been touted as a factor for longevity (Fastame e et al. 2018) contributing to the phenomenon of successful aging (Rowe and Kahn 1987). Perhaps science can learn from the story of the Biblical Moses of the Book of Exodus who is said to have lived to 120 years and his eye sight was good nor his natural force abated (King Henry VIII, 1611b). For forty years in the Wilderness, a dryland area region of the Middle East, the Israelites subsisted on manna a plant based "pastry" which tasted of coriander seed and honey (King Henry VIII, 1611a).

Studies involving determination of extreme longevity have to be carried out meticulously to avoid the errors of myth (Perls et al. 2010) and age inflation (Rosero-Bixby 2008) associated with poor data from self-reporting of the ages of participants in any cohort study. The preliminary studies would involve the analysis of census data to determine the proportion of long-lived individuals whether alive or deceased, and compare this with information from *bonafide* birth registration records (Perls et al. 1999). Research on nutrition is particularly useful as this has yielded important correlations and associations before, such as the prevalence of cancers associated with the consumption of processed and red meats (Rohrmann et al. 2013; Tong et al. 2019) whilst a vegetarian Mediterranean diet has been associated with a better quality of life (Thompson 1993) leading to longevity. Interestingly researchers have gone on to the extent of describing the so-called epidemiology of longevity (Newman and Murabito 2013) as if to suggest the condition as a disease when this can be celebrated as successful aging in which exogenous factors such as nutrition, exercise and the psychosocial environment play a critical role in the quality of life (Rowe and Kahn 1987).

The dryland region of Buhera presents an opportunity for the study of the parameters which make for successful aging and a poor region of the world where intuition and science would suggest the opposite. To the best of the author's knowledge, this hypothesis and the research which will follow it constitute the first attempt at characterising any region in Africa as a blue zone. This is also because the nomenclature of the blue zone is a fairly recent phenomenon (Blue Zones Project 2020) with the usual tendency of the African continent lagging behind on global trends. As such the study aims to therefore recommend the mainstreaming of the cultivation of "small" grains not just as drought resistant crops, not only as part of a health reform agenda (White 1866), good health (Dunn 1959a) in a positive sense and wellness (Dunn 1959b) but combating the global burden of disease especially in the era of viral pandemics such as COVID-19 in which the intemperate use of food (Nabi et al. 2020) is correlated with disease (Sharif-Yakan and Kanj 2014). Further, this study also helps in identifying and promotion of climate adaptation and resilient strategies and practices in dryland agriculture.

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