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# IRRIGATION TECHNOLOGY FOR SMALLHOLDER FARMERS: A STRATEGY FOR ACHIEVING HOUSEHOLD FOOD SECURITY IN LOWER GWERU ZIMBABWE

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***ABSTRACT***

*The problem of food insecurity in developing countries is an enormous challenge. In rural communities, it is a perennial problem that requires undivided attention to ensure household food security. This paper seeks to define the role of rural participation in providing household and community food security with a particular focus on Lower Gweru irrigation project in Zimbabwe. The research comes in light of increased food deficit in Zimbabwe that has been compounded by failed politics, climate change and weather extreme events. Data was gathered using self-administered questionnaires, direct observation and literature review. Data was analysed using the Microsoft Excel 365 ToolPak and Health24 Web Calculator. This paper highlights the importance of rural irrigation schemes in addressing community and household food security and ensuring health nutrition uptake by irrigators and surrounding communities. Rural irrigation systems enable farmers to become net food sellers allowing them to benefit from food price volatility. It also highlights the resultant development and makes recommendations for future irrigation developments.*

**Keywords:** Food security, Zimbabwe irrigation, climate change, nutrition, irrigation.

## 1. INTRODUCTION

Smallholder farmers play a pivotal role in the global agricultural village as they account for 80 percent of food that is produced and consumed in Less Developed Countries (Fair Trade Foundation, 2013; Altieri & Koohafkan, 2008). These smallholder farmers are important contributors to poverty reduction initiatives in developing countries and immensely contribute towards food security efforts (Wenhold, Faber, van Averbeke, Oelofse, van Jaarsveld, Jansen van Rensburg & Slabbert, 2007). Smallholder farmers in Sub-Saharan Africa provide 30-40% of GDP in sub-Saharan Africa economy (Rockström, Barron & Fox 2007). Despite smallholder farmers' significant contribution to ensuring food security they are faced with a host of challenges such as increased population growth, lack of funding and climate change hindering their capacity to increase food production.

Increasing population growth amongst other factors is an obstacle towards achieving food security in many developing countries. The Food and Agriculture Organization (FAO) projects that by 2050, population growth will result in doubled demand for food globally (FAO, 2008 B). Cereals, roots and tubers have a significant role in the food supply chain for

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Sub-Saharan Africa, but their production has lagged behind the rate of population growth (FAO, 2006). High fertility rates increase poverty levels and with a subsequent link to land degradation as they place pressure on agricultural production through land clearance, chemical use and fertilizer (Zuberi & Thomas, 2012).

In most developing countries and Zimbabwe's Lower Gweru, in particular, climate change has exacerbated the challenge of food insecurity by reducing crop yields and increasing production variability. Increased incidences of extreme weather events due to climate change have an adverse effect on food, water, and livelihood security in Sub-Saharan Africa where widespread hunger already prevails (Swaminathan & Kesavan, 2012). Ringler Zha, Kok & Wang, (2010) pointed out that climate change will result in 3.2 percent cereal reduction in Sub-Saharan Africa. The Sub-Saharan Africa region is particularly vulnerable to climate change. The region has low adaptive capacity to climate change due to poor economic performance and technical incapacity as indicated by its overreliance on dry land farming (Ringler 2010; Codjoe & Owesu, 2011). This dependence on dry land farming often results in low crop yields leading to hunger, malnutrition and starvation. The situation has been worsened by climate change in several arid and semi-arid regions all over the world and worsened the fortunes in sub-Saharan Africa (Mutiro & Makurira, 2006; Rockström & Borron, 1999).

These challenges entail that innovative technologies have to be adopted to ensure food security. Irrigation scheme is a critical technology that has been taken to enhance food production since human civilisation. Since climate change results in water scarcity, irrigation projects assist the situation through promotion of efficient water usage (Ngigi, 2009). Thus, irrigation projects can be the answer to food security challenges. The African Human Development Report indicated that the solution to food insecurity is available through research and continued innovation within the agricultural sector. Nhundu & Mushunje (2010) indicated that irrigation farming is a critical industry that increases per unit area food production leading to improvement in food availability and accessibility. Crucially irrigation results in sustainable household economic performance and a broad spectrum of crop production. Irrigation is crucial in facilitating the use of fertilizers, adoption of high-yielding seed varieties that saw yields doubling in doubling of yields between 1995 and 2001. (Hussain & Hanjra 2004).

Unequivocal and substantive significance of irrigation in drought relief savings is better illustrated by comparative analysis of the cost of drought-induced food aid and the investment required to develop irrigation projects that match a similar relief package. Consider 1,000 families living in Natural Region V of Zimbabwe, where rainfall is erratic, unreliable and inadequate for any meaningful dry land cultivation. The aim of the drought relief programme is to supply at least 550 kg annually to each family of six persons. If these families were placed on a drought relief programme, they would require 550 tons of maize per annum. The government expenditure to buy same maize unit, at US$ 45.28 /ton (would be US$ 24905.66. The calculated transport cost would be US$ 2075.47, and the administrative cost would amount to another US$ 3773.58), bringing the drought relief package to US $30754.71 (FAO, 2000). The question, which arises, is, whether small-holder irrigation farm units can produce the equivalent of drought relief and at what cost?

FAO, (2000) made a compelling argument that drought relief food packs do not always get to intended beneficiaries. FAO argued that food packages in the majority of cases contain a combo package comprising of cooking oil and beans that further inflates the cost of food aid.

In the light of the above, irrigation becomes a viable and sustainable option as it reduces donor dependence and results in government savings. It affords smallholder farmers an opportunity to produce food in a dignified manner.

This paper examines the potential role that rural irrigation schemes can play in ensuring household food security in Zimbabwe. It also seek to highlight the lessons from Lower Gweru Irrigation Project, inform future policy development and influence donor developmental funding priority setting in the arid rural areas of Zimbabwe.

## 2. DESCRIPTION OF THE STUDY AREA

Lower Gweru communal area is located in the Midlands province. It is positioned agro ecological region IV of Zimbabwe. This area is characterised by occasional mid-season droughts hence most crops grown are predominantly drought resistant and cattle ranching. Temperature ranges between 11ºc in dry winters and 26ºc in the wet summer that stretches from October to March (Mugandani, Wuta & Makarau, 2012). Lower Gweru lies between $19^{o}$ 14’S and $29^{o}$15’E. It is located 40km North West of Midlands provincial capital city Gweru. Lower Gweru has a population of 93 125 (ZimStat, 2013).The settlement type is mostly linear along roads and a dispersed settlement pattern in remote areas. Lower Gweru has a number of business centres that include Maboleni and Insukamini. The study area lies between Nyama and Mdubiwa ward in the Maboleni area.

## 3. METHODOLOGY

A combination of qualitative and quantitative approach was used in the collection of data. This method is a complementary approach that allowed for, provision different perspectives in answering various specific questions within a broad area (Hancock Windridge, & Ockleford 2007). A self-administered questionnaire was designed to identify food production and consumption patterns by both groups of farmers; dry land and irrigators. The survey captured all the quantifiable crop production aspects, quantity and quality of crops produced by farmers and the number of cropping seasons per year. It also recorded the amount of crops sold, consumed by the family and exchanged crop products. The health and nutritional status, body weight and height of respondents were examined for the analysis of Body Mass Indices (BMI) of respondents. Quota sampling method was used to identify 30 irrigators and 30 dry land farmers for self-administered questionnaire from the irrigation scheme and stakeholders respectively. A separate self-administered questionnaire was designed for stakeholders that included the education institution representatives, health practitioners, agriculture extension officers and community leadership. The field work was conducted in June 2013. In the calculation of Body Mass Indices of irrigators and non-irrigators, the following method was used,

$BMI = \frac{mass(kg)}{height(m)^2}$ = kg/m (Smalley, Kendrick, Colliver, & Owen, 1990; Pietrobelli, Myles, Allison, Galleger, Chiumelo, & Heymisfiled, 1998). BMI was the only feasible indicator, of checking whether food accessibility and availability, have a bearing on nutritional status. Simplistically this has an impact on health status of a human being. BMI tend to vary with health status change (assuming all things are equal).

## 4. RESULTS AND DISCUSSION

### 4.1 Impact of irrigation on food security

There are numerous ways of defining food security, a concept that was developed in 1943 (De Muro & Mazziota, 2011). Regardless of the aforesaid definitional diversity there is consensus that food security is achieved, "when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet dietary needs, food preferences for an active and healthy life" (FAO, 2008 A). This definition formed the basis for the discussion of results. Field survey data indicates that irrigation farmers met all requirements of food security definition. Households who participated in the irrigation scheme had at all times economic and physical access to health and nutritious food. Irrigation allowed irrigating families to enjoy three to four meals a day even in drought years. The irrigators supplement the staple food with other food baskets they purchases using income obtained from cash generated from the selling excess irrigation produce. The surplus commodities are sold to nearby communities both rural and urban given since Lower Gweru is close to the towns of Kwekwe and Gweru. Through irrigation, farmers manage to produce a bumper harvest for household consumption and surplus even in years of meteorological droughts. There was, however, an exception of 2008 and 2012 droughts when irrigators only managed to produce food for family consumption only with the requirement for supplements. The meteorological droughts caused by climate variability and climate change were leading to hydrological droughts in the area. The droughts resulted in water rationing and limited the hectare that was put under cropping at the irrigation. In an unprecedented development, irrigators had to resort donor community and government for food hand-outs as there wasn't available food on the market to purchase. Irrigators indicated that this was an uncomfortable development as donors gave food that irrigators were unfamiliar with in the form of bulgur wheat and yellow maize.

While the field work showed, a food secure irrigation community of 100% in most of the time dry land farmers complained of hunger, starvation and malnutrition. A measly 17% population of dry land farmers reported that they were food secure leaving 87% vulnerable to hunger and famine. They complained that the food hand-outs were neither enough nor reliable due to system bottlenecks. Some suggested that to keep families from starvation they often resorted to selling livestock, gold panning and conduct food for work at the irrigation during irrigation peak season to get food. The results showed that dry land farmers are in perennial food deficit even in years where the entire country receives average rainfall. They indicated that the rain has often been either too little or too much and lack of fertilizers and seed packs as major hurdles in attaining food security. This scenario is highlighted by Rockström *et al.* (2001) who argued that rain-fed farmers in drought-prone tropical Agro-ecosystems experience low crop productivity. Yields from rain-fed agriculture are as small as 1tonne/ $ha^{-1}$ in semi-arid tropical Agro-ecosystems (Rockström, 2001). Rain-fed farmers in Insukamini indicated they only had three months' supply of food from rain-fed agriculture in 2012 due to climate variability. The indication was that the rainfall pattern had become erratic over the years in the region further worsening the predicament of dry land farmers. Expectation was that rain and temperature variability would affect leaf formation, flowering and growth sequentially leading to reduced yields (Devendra, 2012).

As drought mitigation and coping strategy for 2012 dry land farmers had started to engage relatives, government, and donor community for cash and food hand-outs to allow them to purchase food from Insukamini irrigation scheme that always produces surplus food. Some farmers indicated that they were seeking contract work at the irrigation project in exchange for food. Agritex Officials, Environmental Health Technician and CARE International (a humanitarian organisation operating in Lower Gweru) were exploring ways to get food for the rain-fed crop farmers. The above stakeholders indicated that the situation was dire as dry land farmers spent much of their money on food hampering development and expanding poverty in the area. The feeling was that a permanent solution had to be sought to deal with repeated episodes of drought and poverty amongst dry land farmers. However, these strategies address food insecurity are not long lasting. Falkenmark, Rockström & Karlberg, (2009) argues that there is the need to focus on strategies for enhancing water productivity in both irrigated and dry land agriculture in order to achieve food security.

While some farmers took to the growing of small grains such as raphoko and sorghum to augment, the failed harvest of maize (staple food), the yields for small grains remained depressed. The latter were in most instances used to produce traditional beer that was sold and the money used to purchase maize. Though these traditional crops could be produced and are recommended for uptake by health practitioners findings suggests that most families found these unpalatable. Most families shun traditional foods as they are considered an ancient food with no place in modern society. Findings by Mukarumbwa & Mushunje, (2010) however revealed that household food security was more pronounced amongst families growing more drought resistant crops such as millet and sorghum in semi-arid Kenya. However, evidence from fieldwork indicated that small grains (raphoko, millet and sorghum) have received minimal support from government in order to encourage their production in semi-arid regions, compared to maize (Mukarumbwa & Mushunje, 2010). In addition, due to mid-season droughts, rain-fed farmers in Lower Gweru cannot make use of fertilizers as rains do not permit. This further hampers the quality and quantity of their produce.

Due to substantial investments made into the Insukamini irrigation scheme by both government and the donor community such as European Union through provision of extension and technical services, irrigation is capable of boosting household and community food security in rural areas. Irrigators practice intensive commercial farming and engage in multi-cropping of a variety of high yield crops. The business approach that is taken by farmers involved in irrigation is to ensure maximum yields per unit area and this results in maximisation of yield and minimisation of costs. The generated profits from vegetable and crop sales are used to sustain the family through payment of school fees and purchase of food that can't be produced or obtained from the irrigation scheme. The Lower Gweru, Kwekwe and the greater Gweru community drive 45km to buy affordable food and vegetables from the irrigation project at a producer price which is three times lower than at Gweru's Kudzanai and Harare's Mbare Musika crop markets. Locally produced food stuff was found to be 25% cheaper in Insukamini in comparison to the retail market price that can act as a great relief to a liquid crisis-ridden rural population of Zimbabwe. The irrigation schemes provide cheaper alternatives for the poorer urbanites in Gweru and the surrounding communities of Lower Gweru. Thus, irrigation projects at Insukamini have potential to increase safe, nutritious food access to meet the dietary requirements of the host and neighbouring communities.

The above notion is supported by Oxfam (2011), which propounds that irrigation allows the full year multi-cropping, generating higher annual yields per unit area. Irrigation allows farmers an opportunity to diversify and plant alternative cash or food crops. Oxfam, (2011) argues that, for the best results, irrigation should be combined with other measures in enhancing crop diversification, agricultural production yield per hectare, soil management, support for access to markets, and the development of plant and seed banks.

Irrigation schemes could provide a critical food insecurity response as they reduce the burden on government to import food that ensures household food security. A report by KPMG, (2013) revealed that, Zimbabwe depends highly on imported food, and 75% of local goods are acquired from South Africa. Christopher, (2014) indicated that Zimbabwe is set to import 150 000 tons of maize from South Africa to feed 2 200 000 people in rural areas facing hunger in 2014. Agricultural irrigation schemes can potentially reduce the burden on government and donor agencies to provide nutrition. Farmers in Insukamini enjoy the human dignity of producing community food and household food. All the farmers who participated in the survey indicated that since their incorporation into the irrigation scheme they had managed to produce consistently for their families and produced a surplus for selling on the local market. Evidence from government agencies and CARE International staff that were interviewed indicated that irrigators were not given any food emergency assistance as they produced more than enough to feed their families. On that basis, a recommendation was made to either extend the current irrigation or to start new ventures so as to incorporate more farmers and reduce both hunger and malnutrition.

Given the close connection between food insecurity, hunger, poverty, morbidity, the economic crisis and political instability with Zimbabwe having experienced food riots in 1998 it is critical to ensure household and community food security. Irrigation can act as a stabilising factor as it gives farmers an opportunity to produce their food in measures that could support food security. In order for a community to meet its food requirements it has to be able to have physical and economic ability to acquire food in a socially acceptable ways without depleting assets to do so (United Nations, 1975; FAO, 2003). A community that is food secure must offset its production and market variations (Renzalo & Mellor, 2010). The irrigation community in Lower Gweru can be said to be food secure as they have inbuilt ability to produce more than enough food to act as a buffer against global and local food fluctuations. Research points to a food market volatility due to several factors ranging from climate change to world oil price fluctuations. Global food price volatility is expected to be further worsened by increased incidences of climate change and political instability as noted by 2014 Global Risks Report (World Economic Forum 2014). In an increasingly tightly linked, global village increased food price volatility is likely to continue resulting in smallholder farmers and poor consumers increasingly becoming vulnerable to poverty and food insecurity (FAO 2011). However, the irrigators at Insukamini are largely immune to food price market storms being perpetrated by climate change and climate variability, political, economic instability and the fast track land reform programme as compared to rain-fed farmers.

### 4.2 Asset Creation

(Turton, 2000 and Bennett, 2001), postulated that food security encompassed more than aspects of food availability, access and utilization but goes as far as incorporating aspects of asset creation. Asset creation allows systems to be put in place that ensure sustainability during periods of environmental shocks such as climate change and seasonal shortages that undermines food access (Turton, 2000). Results from field work indicated that irrigators were able to build the necessary structures that enable them to withstand shocks, as shown earlier on. Of note is the ability of 75% of irrigators to install boreholes or dip wells on their homestead as compared to 5% of dry land farmers. Wells and boreholes ensure that the community gets safe and clean water to allow for safe uptake of food. In addition, irrigators had relatively more animal asset as depicted in Table 1 and 2. Hamelin Habicht, & Beaudry (1999) indicated that for food security to be attained a household does not have to rely on selling assets as a coping strategy during a period of food shock. Most dry land farmers interviewed indicated that they had to sell some of their livestock to purchase food during shortages. Irrigators on the other hand stated that their 3 farming seasons a year ensured that they had enough food and disposable income from crop sales. Livestock to irrigators was a source of protein for special occasions. It can be concluded that irrigation is an important asset that ensures food availability, accessibility, food utilisation and allows communities to build valuable assets for households and community.

**Table 1: Average Livestock Population/Family Irrigators**

| Livestock | Average Population/Family before Irrigation | Average Population After irrigation involvement |
|---|---|---|
| Cattle | 3.1 | 3.3 |
| Sheep | 0 | 0 |
| Goats | 2.9 | 2.3 |
| Donkeys | 0.4 | 0.4 |
| Poultry | 10.7 | 11.7 |

**Table 2: Average Livestock Population Non Irrigators**

| Livestock | Average Population Per Family |
|---|---|
| Cattle | 1.13 |
| Sheep | 0 |
| Goats | 1.13 |
| Donkeys | 0.63 |
| Poultry | 5.4 |

### 4.3 Public Health Implication

Food security as postulated by Cook et al., (2004) can be measured by looking at nutritional outcomes. Most academics agree that most developing countries, where food insecurity is a challenge, have a primary challenge of malnutrition and hunger-related challenges because developed countries where predominantly there is food security have challenges with obesity. Field results indicated that irrigation farmers were getting the standard 3 to 4 meals a day representing 100% (majority of cases) of irrigators whereas on the other hand the dry land farmers reported that they only afford at least 2 meals a day and in certain instances a day representing 75% of the sample. In that light, a rudimentary approach was taken to compare the nutrition nourishment levels. Assumption was that all things are equal an essential measure of Body Mass Index was conducted to gain an understanding of the levels of malnutrition. This was extended to measure food security and insecurity impact levels on nutrition in rural households in Lower Gweru. Figure 1 and 2 is a depiction of field survey data indicating the BMI values for irrigating and non-irrigating farmers. There is a marked difference between the two households' data with irrigators showing a higher BMI value above the optimum 18.5 further highlighting the significance of irrigation schemes in ensuring food availability, food accessibility and food utilisation. The BMI levels are better for irrigators as they have purchasing power to supplement their diet with other purchased products that aren't directly or indirectly produced by the irrigation. The lack of food amongst dry land farmers had a consequent of lowering the BMI for rain-fed farmers and their households leading to BMI values that are far below the prescribed figure value of 18.5. In addition to sub level BMI levels amongst dry land farmers, 15 children were reported to be on supplementary feeding at the local clinic. Out of a population of 5008 that is served by Insukamini Clinic research found that there was an average of 15 children that were receiving nutrition supplement. Insukamini clinic administers this ready to use therapeutic food (RUTF), alongside other RUTFs such as BP-100, a substantial form of therapeutic milk. The supplement is used to treat malnutrition in famine situations and can be administered at home without medical supervision. All the 15 Children suffering from malnutrition were reported to be from families that aren't involved in the irrigation scheme. Food inadequacy amongst dry land farmers resulted in malnutrition according to evidence from field survey. Irrigation project assisted in reducing food insecurity that causes under-nutrition which affects pregnant mothers negatively increasing chances of giving birth to underweight infants who are in turn vulnerable to birth injury, illness and early death and where these grow they grow to become stunted adults. Stunted children experience compromised physical and mental development, becoming adults with reduced muscle brain (City 2014).

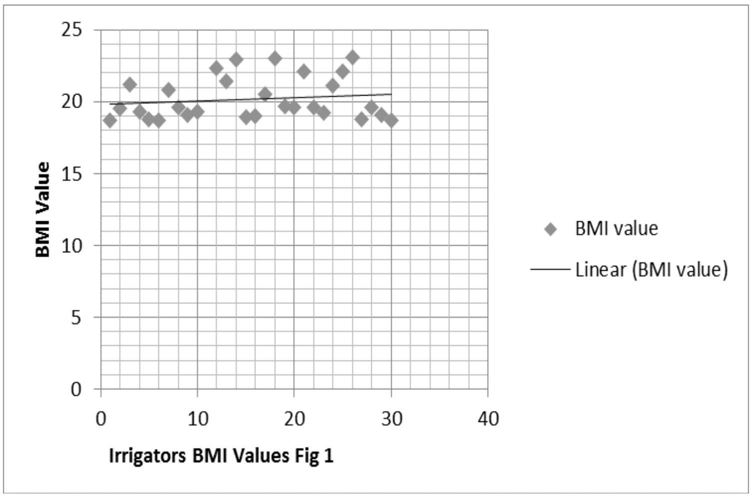


**Figure 1: Body Mass Index of farmers who practice irrigation**

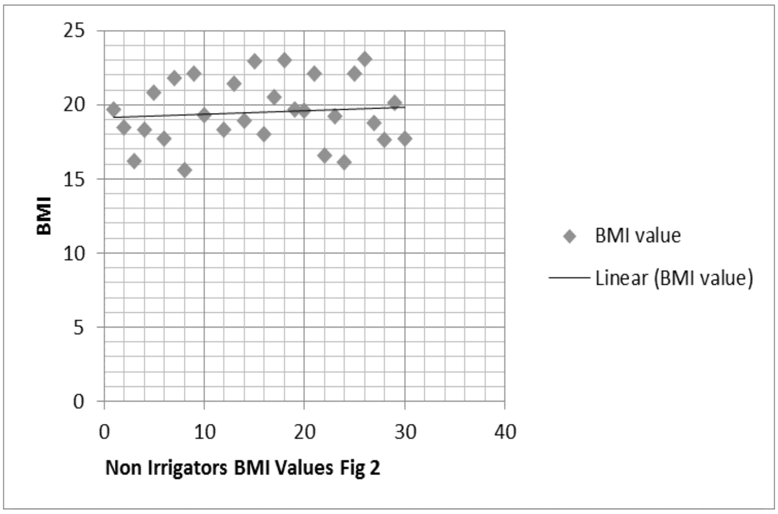


**Figure 2: Body Mass Index of farmers who do not practice irrigation**

## 5. CHALLENGES AND RECOMMENDATIONS

Irrigators are faced with a range of difficulties that if addressed might increase the irrigation's operational efficiency and translate into more benefits for the irrigators and the community. Irrigators indicated that they were experiencing some massive losses through stock theft; that can be attributed to low levels of economic activity and hunger that exists in nearby communities that are not participating in the irrigation scheme. As consequent irrigators have employed general labourers who guard fields day and the night which increases the operational costs for the irrigating farmers. Irrigators also indicated water rationing as a challenge as it limits productivity on plots. Rationing of water was attributed to erratic rainfall supply pattern. There is a need to abandon the current flooding irrigation method and adopt much more sustainable ways of irrigation. To this end, a sprinklers system or more appropriately drip irrigation can be implemented to cater for the fall in water supply from the dam. Drip irrigation would also allow for the expansion of the irrigation scheme

## 6. CONCLUSION

The paper was aimed at assessing impact of family participation in rural irrigation schemes on food security. The findings were that irrigation through multi-cropping enables communities reliable access to health, safe and nutritious food. It also affords farmers an opportunity to self-feed and produce surplus food that can be sold and enable farmers to strengthen food security further through asset creation in tandem with the concept of food security. Most importantly neighbouring farmers suffering the effects of food insecurity as a consequence of climate change and climate variability amongst other factors can buy locally produced food at an affordable price. There is the need to tackle food insecurity for dry land farmers to promote family and rural community development and reduce hunger and poverty. Withstanding the challenges within the sector rural irrigation schemes remain the only viable option in reducing developing countries’ food import bill. This more apt for countries such as Zimbabwe where food production is on a downward spiral owing to climate change, climate variability and change in farmers’ crop production priorities which are leaning more towards cash crop production such as tobacco.

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