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The Role of Innovation in the Growth of Sugarcane Industry in Zimbabwe: A Case Study of Tongaat Hulett

Case Study

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Abstract:

The study's aim was to ascertain the role of innovation in the growth of sugarcane industry in Zimbabwe focusing on Tongaat Hullet. Thus, this was achieved through the use of positivism research philosophy whose views about knowledge, reality and values guided this study. The study shows that there are several challenges hindering growth in the sugarcane industry among them lack of significant of innovation, insufficient financial resources, lack of access to up-to- date technology, poor innovation culture, economic instability and shortage of foreign currency, high inflation, currency instability, policy inconsistency among others. Consequently, the study recommended that sugarcane breeding be established in Zimbabwe, as well as agricultural practices in sugarcane production such as crop rotation, crop protection; water management; soil management; nutrient management; mechanized harvesting among others. In addition, there is need for government to provide sufficient foreign currency to enable the sugarcane industry to grow as well as stabilize the operating environment.

Keywords: Histiocytic sugarcane, innovation, foreign currency, economic instability.

INTRODUCTION

Laws (2010) states that sugar cane originated in New Guinea where it has been grown for thousands of years since about 1000 BC. Thus, the cultivation of sugar cane gradually spread across human migration routes to Asia and India and east into the Pacific (McNeill, 1984; Laws, 2010). Hence, it is thought that sugarcane then hybridized with wild sugarcane relatives of India and China to produce the commercial sugarcane known today (Paungfoo-Lonhienne et al, 2010; Laws, 2010). That said, in Zimbabwe, sugarcane was brought from Natal province into the Lowveld in 1931 by Thomas Murray McDougall and processed into crystals the same year (Mlambo and Pangeti, 1996). In fact, it is vital to note that sugar is a very significant commodity that contributes towards feeding of the mankind (Zahniser, 2016; USDA ERS, 2018; Zulu, 2019). Accordingly, sugarcane offers production alternatives to food, such as livestock feed, fibre and energy, particularly biofuels (sugar-based ethanol) and co-generation of electricity (cane bagasse) (isosugar.org; Zulu, 2019). Hence, sugarcane is generally regarded as one of the most significant and efficient sources of biomass for biofuel production (isosugar.org; USDA ERS, 2018). Thus, it is worth noting that a wide range of environmental and social issues are connected with sugar production and processing, and sugar crop growers, processors, plus energy and food companies are seeking for ways to address concerns related to sugar production, biofuels and sustainability (isosugar.org; Zulu, 2019). For example, in 2016, Cuba was regarded as having the highest average consumption per capita of 51kgs with Zimbabwe at an average of 21kg (www.weforum.org). Hence, the sugar industry contributes 1.4% to the Zimbabwean GDP with more than 25 000 people directly employed while 125 000 people are indirectly employed in sugar industry in Zimbabwe, with more than 60% of sugar produced in Zimbabwe being exported to neighbouring

countries and the European Union making Zimbabwe a net exporter of sugar (Chandiposha, 2013). Thus, the main export destinations for Zimbabwean sugar are the United States, East Africa (Kenya), Botswana, South Africa and the EU (fas.usda.gov). Whilst, Zimbabwe is a beneficiary of the United States Tariff Rate Quota (TRQ) annual raw sugar allocation of 12,636 MT, which allows it to export raw sugar duty free to the United States (ustr.gov).

However, the sad thing is that sugar industry has been facing the many challenges in the recent past years that have inhibited growth as the TRQ amount has remained constant over the last several years and the industry average production has been on 430 000tons sugar for the past 10 years (fas.usda.gov). Thus, the stagnant world market price coupled with dumping of sugar commodity by major producers thus putting pressure on the world sugar arena (www.fao.org; Zulu, 2019). For example, the Zimbabwe sugar market almost collapsed as a result of cheap imports, and this was only saved by introduction of a 10% import duty and US$100 per MT surtax in 2014 for all non-SADC and COMESA origin sugar (www.worldbank.org). In addition, the prevailing prices are not supporting growth of the sector as limited space to grow sugarcane has slowed down horizontal growth of the industry (Dubb, 2013; Zulu, 2019). Thus, the higher the entry barrier into sugarcane farming, the consequence is that sugarcane farming will only attract new farmers that are well funded as the land preparation requirements and irrigation infrastructure on regions that support optimum growth of sugarcane require a lot of capital (unctad.org). Consequently, the situation has been worsened by the Zimbabwean out-growers who are struggling to attract financiers due to land tenure and security around offer letters that are not bankable as the Zimbabwe land policy post land reform program is still tainted and hence requires a lot of market confidence to attract good will from external sources (globalpressjournal.com; Chigunha et al, 2020). In short, vertical growth of sugarcane industry is pretexted on optimizing sugarcane stick growth during farming and efficient extraction of recoverable sugars during milling processes (Zulu, 2019). In short, productivity in farms is measured by tons of sugar cane produced per hectare and for mill-cum-planter, the average productivity has been 89 tons of cane per hectare which is compared to outgrowers at 72 tons per hectare whilst, mill-cum-planter is occupying 24 000 hectares against 21 000 hectares by out-growers (gain.fas.usda.gov). For that reason, there is need to improve productivity to at least 103tons per hectare, of which some sections of fields are achieving. Recovery of extractable sugars during milling is averaging 96% of which best mills are at 98% (wrldbank.org). Thus, an improvement of extraction by 2 units to benchmark with best practices translates to 2% improvement in production (asq.org). Accordingly, this study aims to ascertain the role of innovation in the growth of sugarcane industry in Zimbabwe, focusing on Tongaat Hullet. Thus, this is intended to meet the government's Vision 2030, in addition to assessing the significance of innovation in the growth of sugarcane industry in Zimbabwe.

LITERATURE REVIEW

The Origin of the Sugarcane Industrial Sector in Zimbabwe

It is said that sugarcane originated from Papua New Guinea where sugarcane has been grown for thousands of years since about 1000 BC (Laws, 2010). Thus, the cultivation of sugarcane gradually spread across human migration routes to Asia and India and east into the Pacific (McNeill, 1984; Laws, 2010). Thus, it is thought that sugarcane then hybridized with wild sugarcane relatives of India and China to the commercial sugarcane known today (Paungfoo-Lonhienne et al, 2010; Laws, 2010). That said, in Zimbabwe, sugarcane was brought from Natal province into the Lowveld in 1931 by Thomas Murray McDougall and processed into crystals the same year (Mlambo and Pangeti, 1996). Consequently, the successful sugarcane experiment by Thomas Murray MacDougall at Triangle led to the opening of Hippo Valley in 1954 and Mkwasine in 1968 respectively (Saunders, 1980; Mlambo and Pangeti, 1996).

- **Triangle Estate (1920s)**

Triangle Sugar Estate was founded in 1919 by Tom Murray MacDougall as a ranch but a severe downturn in the economy during the post-World War 1 recession forced him into crop production (Mlambo and Pangeti, 1996). It is worth noting that before they embarked on a successfully crop production, they needed to find a way of harnessing the waters of the nearby rivers for irrigation, since rainfall levels were too low to sustain crop farming (Saunders, 1980; Mlambo and Pangeti, 1996). Hence, the diversion of water from Mutirikwi River into Jatala Weir where it was later directed into cane plantations by canals (Saunders, 1980). Thus, the main crop initially cultivated in the estate was wheat and by 1934 eighteen hectares of sugarcane were under irrigation in the estate culminating in the opening of the first sugar processing mill in Zimbabwe on the estate on 11 September 1937 (Saunders, 1980; Mlambo and Pangeti, 1996).

• Hippo Valley Estates (1956)

Hippo Valley was first established as a citrus estate by Raymond Stockil in 1956 (Mlambo and Pangeti, 1996). Thus, most of the citrus trees planted in the 1950s were uprooted in the 1970s when the company lost most of its market due to the international organisations' sanctions drive which were imposed on Rhodesia (now Zimbabwe) after it had unilaterally declared independence from Britain (Saunders, 1980; Mlambo and Pangeti 1996). Thus, Stockil who was the former leader of the Dominion Party (DP) in the then Rhodesia had given up politics to concentrate on farming (Saunders, 1980). As a consequence, together with six other white farmers, they then formed Hippo Valley Estates Limited (Mlambo and Pangeti 1996; Muromo, 2017). Accordingly, the company soon diversified into other crops like wheat, cotton and the first sugarcane crop was planted three years later in 1959 (Mlambo and Pangeti, 1996). In 1960, Stockil bought a sugar mill from Mauritius which arrived a year later at Hippo Valley (Mlambo and Pangeti, 1996; Muromo, 2017). Immediately after 1960, Hippo Valley launched on an expansion program designed to increase sugar production on the estates and the expansion saw Hippo Valley borrowing money from overseas and selling some of its shares in 1964 (Saunders, 1980; Mlambo and Pangeti 1996; Muromo, 2017). In the process, Anglo American Corporation and Tate and Lyle limited bought 40% and 10% of the shares respectively with the latter selling its shares to numerous Rhodesian financial institutions and pension funds (Saunders, 1980; Mlambo and Pangeti 1996; Muromo, 2017). As a consequence, this soon transformed Hippo Valley into a sugar growing giant which by the early 1980s had one of the most efficient sugar processing mills in Southern Africa (Tongaat Hulett Zimbabwe, 2015; Muromo, 2017).

• Mkwasine Estate (1968)

Mkwasine Estate was sold to Triangle and Hippo Valley on an equal share partnership (Mlambo and Pangeti, 1996; Tongaat Hulett Zimbabwe, 2015; Muromo, 2017). In consequence, the two sugar estates intended to grow sugarcane at Mkwasine but had to initially shelve the thought thanks to lack of sufficient markets due to multi-lateral organizations' sanctions and the sharp fall within the world sugar price (Tongaat Hulett Zimbabwe, 2015; Muromo, 2017). Accordingly, for a time the two sugar companies continued to grow cotton and wheat at Mkwasine (Tongaat Hulett Zimbabwe; Muromo, 2017). For that reason, the conversion from wheat and cotton to sugarcane production began in 1976 (Mlambo and Pangeti, 1996) and was in the midst of a change from overhead to flood irrigation because the extension of the railway line from Nandi Siding to Mkwasine Estate to facilitate the transportation of sugarcane to the mills at Triangle and Hippo Valley was in the process of being commissioned (Muromo, 2017). As a result, the two companies started growing sugarcane at Mkwasine in 1980 using seed cane from Hippo Valley (Tongaat Hulett Zimbabwe). As a consequence, in 1980 that is after Zimbabwean independence, the Chipiwa Settlement Scheme was launched and with a purpose to initiate black sugarcane farming on 10 hectare plots (Tongaat Hulett Zimbabwe; Muromo, 2017). Thus, this was premised on two considerations. Firstly, it was a prerequisite that 40 percent of the available irrigation water be channelled towards private landholders and secondly, as part of the newly independent state of Zimbabwe to involve black farmers in those economic activities that were exclusively for the minority white farmers under colonial governments (Muromo, 2017). Since, Mkwasine Estate which is 50 km and 70 km from Hippo Valley and Triangle respectively has no sugarcane processing mill, its sugarcane was transported to the processing mills by either road or rail for processing and marketing purposes (Tongaat Hulett Zimbabwe; Muromo, 2017).

Sugarcane Growing process in Zimbabwe

Sugarcane can be classified into various categories namely sugarcane varieties, depending on sucrose content and various properties such as percolation rates through a bed of the sugarcane fibre and a few examples of these varieties are NCO376, N14, ZN8 and ZN10 (Shezi, 2017). It is worth noting that sugarcane is planted in the fields in furrows using sugarcane stalks as seed and the furrows facilitate irrigation of the sugarcane by means of siphons from a water supply canal (Griggs, 2004). Other means of irrigation employed are: overhead sprays and center pivot and the sugarcane is planted in sets to allow constant supply of the raw material throughout the production season, which stretches from mid-March to late December (Ndeketeya et al, 2014). Thus, the sugarcane takes about 3 weeks to germinate and growth of sugarcane is enhanced by use of fertilizers (Vuyyuru, 2019). In short, the sugarcane is irrigated until it is mature and this takes about 12 months (Hagos, 2014). Thus, once the sugarcane is mature, it is then burnt to get rid of the leaves which are hazardous to the skin thereby, facilitating the cutting of cane and delivery to the mill (Publica, 2018). Thus, burning of cane is significant because it gives the juice less suspended solids, increases the mill

capacity by about 13 – 15%, reduces length of season, increases extraction by about 0.47% and ensures lower consumption of energy per tonne of sugarcane during milling (Valente and Laurini, 2021).

Sugarcane Delivery in Zimbabwe

Sugarcane is transported to the mill after harvesting in bulk using hilos (approximately 20 tonnes of sugarcane), or in bundles (approximately 5 tonnes of sugarcane) by tractors, trailers and locomotives (van Niekirk, 1981). As a consequence, as the sugarcane arrives at the mill weighbridge, there is a laboratory staff member present who must visually inspect the sugarcane load to check for any signs of excess soil, excess trash, rocks, and loose chains that may be included in the bundles (van Niekerk, 1981; Iryani, 2012). As a result, if a bundle is judged to be unacceptable, the laboratory worker has the necessary authority to reject either the whole bundle, or whole load. In this case, the laboratory is also responsible for taking samples of the sugarcane and analyzing sucrose quality and content (Iryani, 2012). Thus, at the weighbridge, the mass of the laden vehicle as well as the mass of the empty vehicle are recorded and the mass of the sugarcane is obtained by subtracting the mass of the empty vehicle from the mass of the laden vehicle (van Niekerk, 1981; Iryani, 2012). In addition, there is also a rail weighbridge for determining the mass of sugarcane brought by train wagons and the mass of the cane is very important as it gives the knowledge of the hourly throughput and is used to pay farmers (van Niekerk, 1981; Iryani, 2012).

Sugarcane Processing into sugar and associated by-products

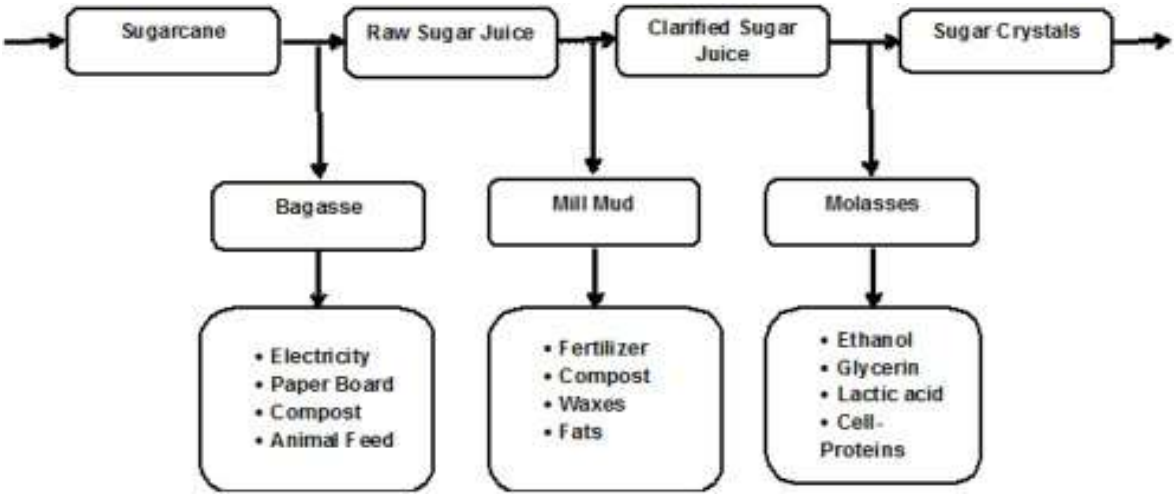


FIGURE 2.1- *Sugar Industry Byproducts at Processing*

(adopted from van Niekerk, 1981; Iryani, 2012).

• Crushing of Sugarcane

The diagram above shows the whole stick sugarcane is loaded into crushing plant by cranes or rail tipplers and it is cut into small pieces in preparation for extraction of sweet juice and after that it is then sent through a diffusion process where hot water is added to counter flow where sugarcane is then the crushed (van Niekerk, 1981). As a result, the crushed sugarcane is then sent to the rolling mill to press any residual juices and by adding dilution water. The extracted juice is then sent for purification into juice clarifiers and unserviceable pressed sugarcane (bagasse), which is then dispatched to boiler as fuel (Iryani, 2012).

• Juice Clarification

Sugar solution (15-20% of solids, 70-90% sucrose) is heated up to 75°C to improve concentration and separate solids (mud) and clarified juice by adding a coagulant (Sahu, 2018).

• Evaporation

Water is removed from the clarified juice by further heating in vacuum boiling cells arrangement (evaporators) to achieve a 60% sucrose concentration (Gunjal and Gunjal, 2013).

• Pan Boiling

The syrup is further heated to form a mixture of solid crystals and concentrated sugar (massecuite); the solution is discharged into natural cooling crystallizer to control growth of sugar crystals (Iryani, 2012).

• Centrifugal and conditioning

The massecuite with full grown grains is sent to rotating type separator with high spinning speed to separate massecuite into sugar and molasses and the brown sugar passes through a dryer with hot air to condition it and screens before sending to silos and the molasses is recirculated for maximum economic recovery of sucrose before discharging into final molasses tanks (Iryani, 2012; Gunjal and Gunjal, 2013; Sahu, 2018).

• Refinery

Brown sugar is converted to white sugar by reheating, melting the brown sugar and subjecting the liquor to discolouring agents to remove the colour and the sugar then undergoes a similar process of pan boiling, crystallization, centrifugal and drying (Gunjal and Gunjal, 2013; Sahu, 2018).

• Packing and bagging

Table white, table brown and raw brown are the main sugar streams from sugar factory and are bagged. In Zimbabwe, sugar is sold in 1kg, 2kgs, 20kgs baller and 50kgs for local and export consumption and 1ton (raw and table) and bulk raw sugar is only for local industrial and exports. Marketing and Sales is joined under one stop shop, Zimbabwe Sugar Sales, responsible for all sugar and by-products sales (Tongaat Hulett Zimbabwe).

• By-products

Molasses, mill mud, ethanol and electricity are the main by-products. Effluent streams are mill effluent water, stack emissions, boiler ash (Tongaat Hulett Zimbabwe)

The Significance of Sugar Industry in Zimbabwe

It is worth noting that sugarcane industry is significant to Zimbabwe and its set up in remote areas brings with it many benefits such as provision of infrastructure and service in which Tongaat Huletts supports a total of 18 primary schools and 4 secondary school that service its employees and personnel who service it. Such service provision supports the government Vision 2030 and basic human rights (www.tongaat.com; fas.usda.gov). Furthermore, direct employment provision of 18,000 people, plus several casual workers across its two mills and estates. 870 sugar cane outgrowers employ a further 7,000 people and the industry creates the much needed employment as it is labour intensive (www.tongaat.com; www.drishtiias.com). Moreso, many service companies, government institutions, civil institutions benefit by offering support services thereby adding to the number of employment created, income tax, corporate tax and sales tax revenue base is improved (www.tongaat.com; www.drishtiias.com). Furthermore, promotion of commercial farming models, have an impact on the sugarcane sector as well the national economy and thus, the industry partakes in commercial sugarcane farming and efficient use of dry land through effective farming methods (www.tongaat.com). Consequently, an extension office and Zimbabwe Sugar Experiment Station among others have been established by government to support the industry and agronomy is in control of plant diseases and a variety of development projects (www.tongaat.com; www.howwemadeitinafrica.com). Thus, a win-win self-sustaining farming model is fostered by miller and farmer which can be a model to use for other crops in other parts of the country against the command farming model (Nyathi, 1999; Chingarande et al, 2020). Equally, bulk buyer of key consumables and equipment means that the industry is a bulk user of fuel, diesel and fertilizers and the industry uses an average of 350kgs per hectare of AN (ammonium nitrate) and 180 kgs per hectare of SSP (single super phosphates) making it the biggest consumer of such (www.tongaat.com). Similarly, Export Creation and Forex Earning means that the industry has a guaranteed export quarter to EU markets over and above sales to Botswana, Namibia, and DRC and the much-needed foreign currency is received by sales of above 200 000 tons of sugar in regional and overseas markets which is in support of government Vision 2030 and STSP (www.tongaat.com). Additionally, import substitution, which means the sugar industry produces green electricity for its own use by burning bagasse and excess power is channelled into the ZESA grid (Chingarande et al, 2020). Currently, the country has an overall power deficit and is importing to complement local production and the savings of foreign currency is realized by supporting the co-generation initiatives of sugar industry (www.tongaat.com). Furthermore, the industry is also producing fuel grade ethanol that is blended with petrol to make E15. E15 is flex fuel with 15% of ethanol and 85% petrol. Consequently, the generation of locally made fuel is reducing petrol fuel import bill by 15% (Zuurbier and Vooren, 2008: Johnson et al, 2020). Accordingly, it is also worth mentioning that molasses as a by-product is a primary raw material for manufacture of animal feeds and baking yeast and its current use is presently improving the country's herd as it is used as a provision of much needed nutritious animal feeds though at a minimum level something that could be improved with the use newfangled innovation (van Niekerk, 1981; Johnson et al, 2020).

Likewise, the sugarcane industry also produces sugar and ethanol which are raw materials for the bakery, beverage and chemical industries (Zuurbier and Vooren, 2008: Johnson et al, 2020). For example, refined sugar is required for manufacture of beverage drinks, bread and confectionaries. Whilst, ethanol is either absorbed by fuel industry as energy or further processed to make alcoholic beverages (spirits) and industrial raw materials (paints and medical) (van Niekerk, 1981; Zuurbier and Vooren, 2008: Johnson et al, 2020). Lastly, sugarcane industry produces table sugar which is consumed Zimbabwe at an average of 30kgs per capita and this table sugar is consumed in teas among as well as other beverages and confectionery (www.isosugar.org: fas.usda.gov).

The challenges being faced by Zimbabwe Sugar Industry

• High Entry Costs (land prep, machinery, experience)

Notwithstanding all the benefits that are derived from the sugarcane industry that were mentioned elsewhere in the study, the industry by tradition experiences so many challenges especially in developing countries such as high capital which is required for farming and processing equipment, and this dates back to the introduction days of the industry as noted by de Vries (1969). Moreso, when the farmers are at the land preparation stage which requires heavy use of machinery to allow levelling, ridging, water drainage, fertilizer application, weeding and pest control (www.agmrc.org). Hence, few players who invested in the industry find it difficult to switch due to lack of funding which always delays replanting and capitalization of equipment leading to reduced efficiencies (Vries, 1969; www.agmrc.org).

• Pest and Disease Attacks

Smut, ratoon stunt disease, leaf scald, brown rust, orange rust, yellow leaf are the main diseases affecting Zimbabwe sugar cane crop and eldana, sugar cane yellow aphid and back maize beetle are the main pests of concern (https://vikaspedia.in; www.oecd-ilibrary.org). Even though, ZSAES (Zimbabwe Sugar Association Experiment Station) routinely scouts for pests and disease in cane farms (https://apps.fas.usda.gov).

• Impact of Land Reform Policy

There is still transfer of sugarcane farming techniques required for some farmers to operate at commercial basis as yields of some allocated farmers are depressed to as low as 30tons per hectare against an average of 100tons per hectare (www.fao.org). As a result, some land has been converted to other crops that are not supported by the region condition hence poses as a biosecurity risk (www.fao.org; www.apn-gcr.org). Thus, to make matters worse funding is difficult to access especially for A1 farmers (outgrowers) as the government offer letter are not bankable and resulting in the outgrowers ending up relying on contract farming which is being offered by the miller which are not favourable (www.herald.co.zw).

• Water Rights

Zimbabwe sugarcane relies on irrigation and the main water sources are (Lake Tugwi Mkosi) 85km, (Lake Kyle) 198km and (Siya) 76km and water flow by gravity in a network of canals from the sources to holding dams on Estates (www.herald.co.zw). In this case, the water channel infrastructure is maintained by ZINWA and unfortunately, the infrastructure is suffering from continuous vandalism along the route where residents are tapping water for domestic use, irrigation and animal husbandry (www.zinwa.co.zw).

• Technological Support

Zimbabwe sugar cane industry relies on Tongaat Huletts (SA) for technological support, which is a full member of SMRI (supported by KwaZulu Natal University). In fact, Zimbabwe mills are also affiliated to SMRI and pay fees to share benefits like benchmarking, sugar conferences, sugar technology training. All Southern Africa mills make up the pool (www.universityworldnews.com). Whilst, local universities and technological institutes do not offer sugar technology courses (http://www.rcz.ac.zw; www.universityworldnews.com). Zimbabwe Sugar Research & Experiment Station (ZSRES) offers sugar cane extension services and research (http://www.rcz.ac.zw). Training and certification of key operation competencies is farmed from SMRI (www.ilo.org). In consequence, sugar technology expertise in Zimbabwe is scarce as the industry is unique and not comparable to any other industry and replacement of key competencies requires expatriation services.

• Weather Threats (Droughts & Flash floods)

It is unfortunate that sugarcane crop suffers moisture stress during droughts or when there is low water level in main water sources such as Mutirikwi Dam as water is then prioritized for domestic use and animal husbandry (www.adaptation-undp.org). The unfortunate thing is that flash floods are also a potential threat as the Lowveld is on low lying land (www.weather.gov) and in the past many cyclones have affected the region with incremental weather conditions inducing forced harvesting stoppages,

whirl winds that destroy crops and torrential river floods that wash away cane crop (https://reliefweb.int).

• Burn to Crush deterioration

Burn to Crush deterioration is a measure of time (in hours) taken between burning and crushing cane and therefore, the number should be a single digit but delays caused by cane cutting and hauling methods leads to cane deterioration and loss of sucrose (Misra et al, 2022).

• Sharing of proceeds between farmer and miller

There is always a contentious rivalry between farmer and miller as far as sharing of proceeds is concerned, as farmer feels prejudiced by miller and that notion works against business efficiency and improvement (Donaldson and Walsh, 2915).

• Depressed sugarcane prices

World sugar price is low caused by a combination of overproduction and change in consumers' taste and EU export quota has been reducing over the years (Trejo-Pech et al, 2020). In addition, East Africa countries like Kenya and Congo are also increasing their land under sugarcane production leading to potential markets being net exporters (Zeleze, 1988; Sandrey and Vink, 2007).

• Lobby against sugar consumption

It is worth noting that millennial customer tastes are ever changing and the lobby to reduce consumption of sugar per capita is putting pressure on the industry (www.theguardian.com) and therefore, people are now widely read and promotion of health eating is increasing and such pressure groups have managed to lobby for a sugar levy to reduce consumption (www.thesait.org.za).

• Inadequate Government Support

There is no government policy in support of biofuels and electricity co-generation in Zimbabwe as biofuels and electricity co-generation are taken as by-products, yet they are a game changer in the sugar industry (www.zera.co.zw; www4.unfccc.int). For example, co-generation is not paid in cash but exchanged using a banking arrangement (To et al, 2018) and the pricing of biofuel is controlled by the government and is not lucrative to supporting expansion (www.fao.org). In consequence, if the two products were well supported, then they have a potential of being the main products and sugar relegated to a by-product.

• Import Threats

Zimbabwe has not been spared by sugar dumping threat by influx of imports (Sikuka, 2017; https://apps.fas.usda.gov). Though an import customs duty of 10% and US$100/MT surtax was introduced by government on all imports from countries other than SADC and COMESA, notable incidents of imports are still being reported (Tshuma, 2022). The imports are coming in as bottled specification sugar, which is not restricted, but finds its way competing with local table sugar.

What is Innovation?

Innovation is often used capriciously yet, innovation means 'to create to some degree new' (Stenberg, 2017). In fact, to create to some degree new, you need to generate a new idea (invention and creativity), in order to cultivate this idea into an authentic product or service (realization) as highlighted by Aronson (2008) and Stenberg (2017) as well as applying and promoting this newfangled notion (implementation) as noted by Aronson (2008). In short, to create some newfangled product or service refers to supplanting hoary ideas or products or services with newfangled ones (Stenberg, 2017). Accordingly, this is achieved through bringing up-to-date and improving products or services repeatedly (Aronson, 2008). In short, innovation is defined as the process of translating an idea or invention into a good or service that creates value or for which customers will pay (Drucker, 2006) and he describes innovation as an idea that satisfy a need and must be replicable. Thus, this involves deliberate application of information, imagination and initiative in deriving greater or different values from resources and includes all processes by which new ideas are generated and converted into useful products (Auer and Tsiatsos, 2018). In consequence, when a company applies ideas that further satisfy customer needs and expectations, it is termed business innovation (Khadka and Maharjan, 2017). Whilst, social innovation is created when new methods alliance creations, joint venturing, flexible working hours and creating purchasing power is attained (Drucker, 2006). Thus, the process of innovation is a risk taking exercises that involves creating new markets through introducing revolutionary products or technologies (Ringberg et al, 2019). In fact, innovation as suggested by Higgins (1995) is applicable to all sectors of the economy covering products, processes and services and spanning from traditional to high-tech, public to market consisting incremental, radical, process upgrading, quality inspection system and product prototyping on computers. As a consequence, organizational implementation of quality circles, teleconference

meetings and many other innovations are as a result of combinations of existing knowledge and new uses of creativity in both product and process design (Aalbers and Whelan, 2021) and this is why Higgins (1995) suggested that technology is increasingly becoming indispensable in terms of developing, manufacturing and distributing products and services. Whilst, Drucker (2006) suggests that imitators are less risk takers as they are starting on an invented product that has been tried and tested on the market.

Issues related to Innovation

• Sources of innovation

Innovation can be from several sources but notable ones are by chance through focused effort or as a result of major system failure (Fagerberg, 2009). Thus, according to Drucker (2006) the general sources of innovations are different changes in industry structure, in market structure, in local and global demographics, in human perception, mood and meaning, in the amount of already available scientific knowledge. Therefore, an example of manufacturer innovation is where an agent (person or business) innovates in order to sell the innovation (Drucker 2006; Engelberger, 2009). In fact, end-user innovation is where an agent (person or company) develops an innovation for their own (personal or in-house) use because existing products do not meet their needs (Hippel, 2005). In consequence, Engelberger (2009) a robotic engineer asserts that innovations require only three things: a recognized need; competent people with relevant technology, and financial support. As noted by Davila et al (2006), companies cannot grow through cost reduction and re-engineering alone but should invest in innovation as it is the key element in providing aggressive top-line growth and for increasing bottom-line results. Thus, the programs of organizational innovation should be linked to its goals, objectives, business plan and market competitive positioning. In consequence, a survey done by Engelberger, (2009) showed that organizations with systematic programs are driven by improved quality; creation of new markets; extension of the product range; reduced labor costs; improved production processes; reduced materials; reduced environmental damage; replacement of products/services; reduced energy consumption and conformance to regulations.

• Diffusion of innovation

Diffusion is the way in which innovations spread through market or non-market channels and without diffusion, an innovation will have no economic impact (OECD, 1992). Therefore, diffusion is a way that makes innovation benefit society at large. Accordingly, advancement in products and processes are crucial for productivity improvement. Through diffusion, the innovating firms are not the only ones that benefit from their innovations but higher productivity and standards of living for whole economy can be achieved by diffusion as argued by Narr and Noailly (2017). Thus, diffusion of innovation is favorable given that it helps disseminate new techniques, products and services to the wider economy and in the process allowing the full benefit to be gained (Dearing, 2009). Therefore, the importance of diffusion has attracted vast amount of research interest in this area and there is a well-developed body of research looking at diffusion of innovations (Rogers, 1983). Hence, the main elements of the diffusion process are the innovation itself; the population of potential adopters; their decision-making process and the flow of information concerning the innovation between the manufacturers and the adopters. The key parameter used in the discussion of diffusion process is the rate of diffusion (OECD, 1992).

• Innovation and competitiveness

Business environment is now VUCA (volatile, unpredictable, changing and ambiguous) and innovation is the key to stay on top of competition (Nowacka and Rzemieniak, 2022). The values created by innovations are often manifested in new ways of doing things or new products and processes that contribute to wealth (Berglund, 2007; Braunerhjelm, 2010). That is, if the firm is considered as a bundle of resources, skills and competencies, then the effect of innovation is to transform a firm's inner capabilities, making it more adaptive, better able to learn, to exploit new ideas (Zahra and George, 2002). This enhanced flexibility is crucial in the face of changing market conditions and thus, innovation enhances competitiveness of firms (Drucker, 2006).

• Barriers to innovation

Lack of infrastructure, deficiencies in education, inappropriate legislation, training systems and an overall neglect and misuse of talents in society are external barriers to expect (Barrettt et al, 2019). Accordingly, major internal barriers include rigid organizational arrangements and procedures, hierarchical and formal communication structures, conservatism, conformity and lack of vision, resistance to change, and lack of motivation and risk avoiding attitudes (Reilly, 1998). In this case, the factors that are perceived to be restrictive to product/ process innovation are fear of imitation, high costs of innovation, insufficient government

support, lack of information, lack of qualified personnel, no market or insufficient knowledge about markets, and shortage of support/infrastructure in the organization. (Attewell, 2003).

• External environment

It is worth noting that innovative companies are proactive in their approach towards customer satisfaction which is their key performance driver (De Mendonca and Zhou, 2019) and they also know their markets and benchmark performance against competitors and the world's best in class regardless of functions (Aysenur and Erbiyik, 2019). Thus, these innovative companies develop strong supplier relationship and are actively involved in partnership sourcing and strategic partner's innovative companies seek active collaboration with other companies and academia to maximize knowledge and minimize risk (Larsonn, 2005).

Factors that Effects Organizational Creativity

Adapted from Antanopoulos et al (2009)

• Organizational Climate

Bowler (1965) and Morgan (1991) described Organizational Climate as concerned to atmosphere or mood and in this case, he referred to atmosphere that favours creativity and innovation and which requires participation and freedom of expression but also demands performance standards. According to Feurer et al's (1996) research in Hewlett Packard, suggest that creativity is best achieved on open climates where there is interaction with small barriers, large number of stimuli, freedom of experiments and possibility of building on earlier ideas.

• Leadership Style

It is worth noting that there is a consensus that a democratic, participative leadership style is conducive to creativity (Nystrom 1979), whereas an autocratic style is likely to diminish it (Dyczkowska and Dyczkowski, 2018). Hence, Locke and Kirkpatrick (1995) suggested that a leader's vision is key factor when managing creative individuals. For alignment of goals and vision a leader should take a center stage (Wang et al, 2019) and goals and visions are a transcendent goal that represents shared values, has moral overtones and provides meaning and reflects what the organization's future could and should be (Ford and Gioia, 1995). In consequence, Cook (1998) recommends that operational leaders must effectively communicate a vision conducive for creativity through any formal and informal channels of communication and must constantly encourage employees to think and act beyond current wisdom. Thus, the vision must be communicated from highest to lowest level of management (Kimberly and Evanisko, 1981; Debecq and Mills, 1985). Consequently, past works by scholars such as Pelz (1956) and Amabile (1998) hypothesize that leaders should balance employee freedom and responsibility

without domination or control whilst, at the same time they have to show concern for employee feelings and needs. Hence, a creative culture recognizes and encourages employees to voice concerns, constructive criticism and provide feedback (Tedla, 2016; Osbrne and Hammoud, 2017; Naqvi, 2020).

• Culture

It is worth noting that culture is a major challenge in creating a working environment that nourishes innovative ways of addressing problems and finding solutions (Price, 2019; Heathfield, 2020). In fact, organizational culture is described as the deepest level of basic values, assumptions and beliefs which are shared by actions especially from leaders and managers and to encourage creativity within their working environments (Johnson and Scholes, 1984; Morgan, 1991; Locke and Kirkpatrick, 1995; Cook, 1998). Furthermore, Brand (1998) assets that a structured organization needs to develop innovative (divergent and learning), supportive (empowering and caring) culture. In this case he discourages controlling (convergent and efficiency conscious) and directive (profit before people) culture as they hinder creativity in the working environment. This was also supported by Key's (1989) who was also involved in studying high tech industry to support these claims by Brand. Likewise, creativity is fostered in these structured organizations because when individuals and teams have relatively high autonomy in their day to day conduct and a sense of ownership and control over their own work and ideas then they become efficient and effective in achieving their goals (Amabile, 1996). Hence, Amabile and Gotimer (1984) suggest that individuals generate more creative work when they choose how to go about achieving their tasks. In consequence, stimulating and ensuring participative safety bias has been noted as an important element of organizational culture (Anderson et al, 1992) because it is assumed here that employees tend to think creatively if they are not afraid of criticism and punishment hence, the need to encourage them to think productively. In this case, the thinking is that creativity is supported where managers take a long term view in order to tolerate a few mistakes. Hence, Locke and Kirkpatrick (1995) describe an organizational culture which supports creativity should nourish innovative ways of representing problems and finding solutions and regards creativity as both desirable, normal and considers innovators as role models and heroes.

• Resources and Skills

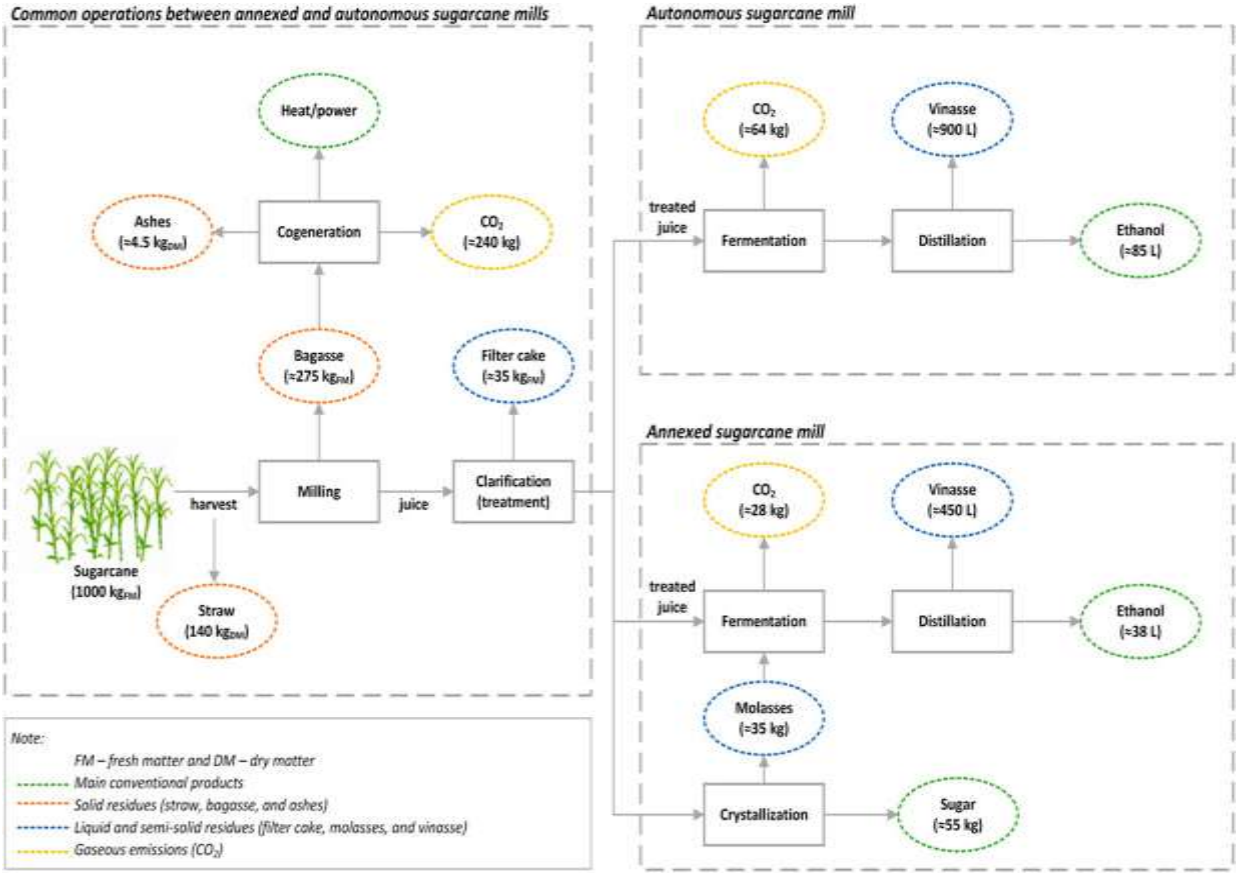
It is important to note that creative organizations should focus on employing people with broader interests and who are eager to learn and prepared to take some risk when at work (Amabile and Khaire, 2008). Hence, Cook (1998) suggest that creative organization must explicitly strive towards attraction, development and retention of creative talent if they want to remain competitive. Thus, the development and retention must be provided by senior management through provision of sufficient resources and training, encouragement for developing new ideas, time to work on pet projects and financial support (Anderson et al, 1992; Jones and McFadzean, 1997). Likewise, Amabile (1998) urges that time and money are the two main resources that affects creativity. In addition, lack of proper resources can constraint employee creativity and managers should allow experiments to be carried out and avoid unknowingly stand in the way of creative process. Thus, findings by Amabile (1998) and Amabile and Gryskiewicz (1987) which state that some degree of pressure within the work environment can have a positive influence on creativity if it is perceived as arising from the urgent, intellectual challenging nature of the problem itself. For example, time pressure as a consequence of an urgent deadline may add to the perception of challenge. Thus, matching individuals to work assignment on basis of both skills and interest and to maximize a sense of positive challenge in the work was found to have positive influence and therefore, enhances employees' creative abilities (Paolillo and Brown, 1978; Siegel and Kaemmerer, 1978; Amabile and Gryskiewicz; 1989; Amabile, 1998). Hence, Amabile (1998) stresses the importance of the amount of 'stretch' within an organization. In this case, Amabile suggested that employees should not be stretched too little as they become bored or too much because this could make them feel overwhelmed and threatened by a sense of loss of control. Thus, to balance this situation, managers need to have detailed information about their employees assigned tasks all the time (Amabile and Gryskiewicz; 1989).

• Structures and Systems

Amabile (1998) state that creativity is truly enhanced when entire organization supports it. Therefore, leaders must put in place appropriate systems and procedures which emphasize that creative effort is a top priority within the company. Hence, Cook (1998) suggests that organizational structures and systems are formal and informal processes within the company and rewards, recognition and career path make up the system. Accordingly, research of 3M by Brand in 1998 suggest that lifetime employment and

promotion from within an organization are important traditional policies and therefore, structures should be flexible and with few rules and regulations, loose job description as well as high autonomy to support creativity. In this case, creativity rewarded is creativity entrenched in an organization. Hence, innovation scholars, Cummings (1965), Amabile et al. 1983 and, Abbey and Dickson (1983), suggest that creativity can be enhanced by expecting a reward that is perceived as bonus, a configuration of one's competences, which can take the form of financial reward or verbal praises. Hence, Amabile (1997), suggests that intrinsic motivation is conducive to creativity and controlling extrinsic motivation is detrimental to creativity but informational or enabling extrinsic motivation can be conducive, particularly if initial levels of intrinsic motivation are high. Thus, in summary the principle suggest that employees will be most creative when they feel motivated primarily by their interest, satisfaction and challenges of the work itself and not by external pressures. However, Amabile and Gryskiewicz (1989) and Amabile et al (1996) accept that extrinsic motivations such as reward and recognition for creative ideas together with perpetual constructive feedback supports creative achievement.

Sugarcane processing and by-products



Adapted from Pina et al (2015)

Sugar processing industry does not only serve the food diet, but by-products play a significant role in energy generation, medicines and chemical products as noted by Pina et al (2015). Thus, sugar by-products are divided into three streams mainly: bagasse, press mud and molasses. A number of downstream industries operate by taking the by-products as feedstock (Niekerk, 1981; www.fao.org; https://wedocs.unep.org).

• **Bagasse**

Bagasse is the remains of crushed sugar cane left after extracting sucrose juice and it is made of fibre and comes handy in generation of electricity to support sugar factory power requirements, irrigation power and excess power being fed into the nation grid (Gopalakrishnan, Michael Nahan, 1977; Mbohwa and Fukuda, 2003; Deepchand, 2005). In this case, the fibrous material burns readily in

boilers and can substitute non-renewable fuel source like coal (Mamvura and Danha, 2020; https://world-nuclear.org). Hence, many countries are increasingly investing in co-generation systems of power to compliment the traditional coal or hydro electrical power and the ash left after burning bagasse, being rich in silica, is used as soil fertilizer and in glass manufacturing (Gopalakrishnan, Michael Nahan, 1977; Mbohwa and Fukuda, 2003; Deepchand, 2005). Furthermore, bagasse is also used in pulp and paper industry as feed stock to make hardboard and packaging material (Gopalakrishnan, Michael Nahan, 1977; Mbohwa and Fukuda, 2003; Deepchand, 2005).

• Molasses

It is important to note that sugarcane can produce molasses, a by-product of sugarcane which is rich in sucrose, water fructose, reducing sugars, carbohydrates and other nitrogenous compounds (Curtin, 1993; Behera et al, 2012; www.fao.org). Thus, in raw form, molasses is used as cattle feed as the enriching nutrition (Naghashyan, 2018), as well as for alcoholic industry, acetic acid, bioethanol, bakery yeast, chemical solvent, micronutrient and cattle feed (Sahu, 2018). In consequence, when molasses undergo fermentation, cardon dioxide comes out as a by-product that has uses in food preservatives and beverage additives (Steinkraus, 1992). In addition, ethylene produced by hydrolysis of ethanol is also used in textile industry (Salusjarvi et al, 2019). Whilst, acetic acids produced by oxidation is used in cosmetics, coatings and varnishes. Acetone is used as a chemical solvent in pharmaceutical industry (Hidzir et al, 2014). In short, alcohol has many uses in labs as well and can be used as internal combustion engine fuel and in chemical industry (Law and Law, 1993; Nieuwenhuis and Wells, 2003).

• Press Mud

Press mud, also known as filters cake, is rich in inorganic material and used as fertilizers to improve agricultural productivity (Kumar and Chopra, 2016). Therefore, crude wax is extracted from press mud to make lighting and cooking jelly and polishing industry wax (Inarkar and Lele, 2012).

RESEARCH METHODOLOGY

This study adopted the positivism research philosophy whose views about knowledge, reality and values guided this study in its quest to understand the role of innovation in the growth of sugarcane industry in Zimbabwe. In fact, positivism is commonly associated with experiments and quantitative research and hence, is considered a form of or a progression of empiricism (Ryan, 2018). In addition, foundationalists believe that hypotheses should be proven through value-free, controlled experiments or observations and that true knowledge should be incapable of being wrong (Howell, 2013). Thus, a primary goal of positivist inquiry is to generate explanatory associations or causal relationships that ultimately lead to prediction and control of the phenomena in question (Saunders et al, 2016; Park et al, 2020). Hence, the reason for using positivism research philosophy in this study was that results were correct because researcher kept their emotions out of the experiment unlike in the phenomenology research philosophy (Saunders et al, 2016; Park et al, 2020). Consequently, face to face interviews were used in this study in order to collect data from the study's key informants. Accordingly, this was achieved using interview questionnaire with structured questions (Munyoro, 2014; Saunders et al, 2016). It is also worth noting that the study adopted diverse data analysis techniques such as IBM's Statistical Package for Social Sciences (SPSS) Version 26 and Microsoft Excel to analyze quantitative data. In fact, descriptive statistics like frequency counts and cross tabulations were initially used to analyze the demographic data collected in the study, as well as thematic analysis. The specific data analysis methods adopted were customized to the requirements of each objective.

Thus, the calculations used to come up with a sample is shown below:

S=N*X/(X+N-1) and X = Z2pq/e2, where p=0.5, q=0.5, Z=1.96 and N=population size

X = 1.962*0.5*0.5/0.052

=385

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

- **Challenges facing the growth of sugarcane industry in Zimbabwe**

TABLE 4.1- *Challenges facing growth at Tongaat Hulett*

	N	Mean	Sig. level
Lack of sufficient financial resources	16	4.57	.32
Lack of sufficient skilled labour	16	2.32	.38
Lack of access to up to date technology	16	4.11	.48
Poor innovation	16	3.64	.39
Economic instability	16	4.73	.42

Shortage of foreign currency	16	4.19	.35
Poor demand	16	2.47	.18
Valid N (listwise)	16		

The findings in Table 4.1 indicate that the mean score on the challenges hindering growth at Tongaat Hulett was found to be 4.57 and the ANOVA p value was 0.32 among them lack of sufficient financial resources in supporting research and innovation. Therefore, there is no innovation taking place at Tongaat Hulett in particular and the sugarcane industry at large. Interestingly, this was also noted by Rusike (2012), who found out that lack of sufficient financial resources in supporting research and innovation was among other major factors that are affecting businesses in Zimbabwe. In addition, lack of up to date technology had a mean score of 4.11 and a p value of 0.48 and this is also in agreement with Zulu (2019)'s findings which found out that there is lack of access to modern technology in the sugarcane industry in Zimbabwe and hence, is hindering growth at Tongaat Hulett as well. Thus, this concurs with Jesús Nieto and Miles (2012) who also asserted that the importance of innovation in the survival and growth of business organisations cannot be undervalued. Whilst, economic instability had a mean score of 4.73 and a p value of 0.42. Thus, this shows that economic instability is among the challenges seriously affecting the growth at Tongaat Hulett. In addition, shortage of foreign currency had a mean score of 4.19 and a p value of 0.35 and this indicates that shortage of foreign currency is one of the major challenges hindering growth at Tongaat Hulett and this was furthermore supported by the interviewees who cited shortage of financial resources as a major impediment to growth in the sugarcane industrial sector. For example, one interviewee explained that, "our operations are very much constrained due to lack of sufficient foreign currency. What we get from the government most of the times comes very late, even when it comes it is not sufficient for requirements". Interestingly, Zivenge and Jesythomas (2014) also highlighted the negative effect of shortage of foreign currency on the agricultural sector in Zimbabwe which sugacane sector also falls. Thus, the issue of foreign currency shortages in Zimbabwe has been cited by several scholars including Chandiposha (2013) as a stumbling block in promoting innovation and technology as this process also involves buying equipment from outside the country. Another issue hindering promotion of innovation is inflation and currency instability among the main challenges hindering growth in the sugarcane industry. "Inflation has always been a formidable challenge for any business operating in Zimbabwe. With such high levels of inflation as we have witnessed recently you can't plan and the erosion of value is very swift, hence growth becomes a big challenge", lamented one of the executives.

In addition, the majority of the interviewees lamented policy inconsistency among the major challenges hindering growth in the sugarcane industry. One interviewee had this to say, "Government policy changes so fast that it's very difficult to keep pace. You find out that there are too many statutory instruments coming out of nowhere, disrupting business transactions, relationships and market dynamics. So I think it is one of the major changes that we are facing in Zimbabwe". Thus, the findings agreed with Zivenge and Jesythomas (2014), who highlighted that the detrimental role played by policy inconsistencies on the growth of businesses in Zimbabwe. The interviewees castigated the financial sector for failing to provide sufficient and cost effective loans that are needed to expand and upgrade their production facilities and these results are in line with Chisango and Tichakunda (2018), who underscored the need to sufficiently finance the agricultural sector in order to ensure food security in Zimbabwe.

- **The existence of innovation in the sugarcane industry in Zimbabwe**

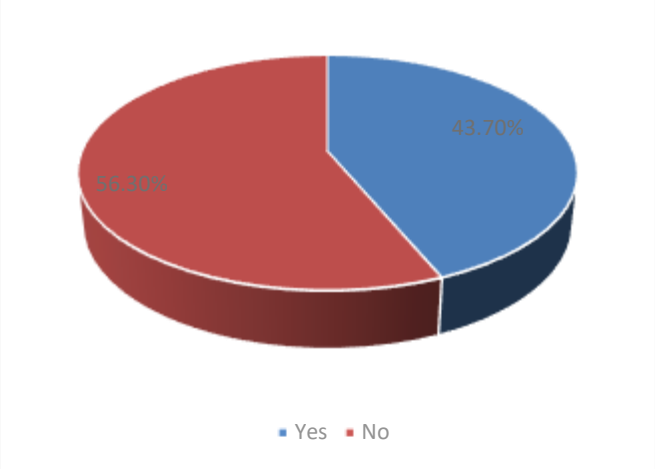


FIGURE 4.1- *Levels of innovation at Tongaat Hulett*

Source: Authors

Fig 4.1 shows that 56.3% of the respondents think that there is no significant innovation in the sugarcane industry including at Tongaat Hulett. Yet innovation helps to increase sales and help to capture larger market share through producing quality products. In addition, innovation increases

cost efficiency and improves value addition thus, which results in profitability. Thus, this is in line with Monge-González and Hewitt (2010), who asserted that the crucial role played by innovation in enhancing profitability is not questionable. In addition, these findings also agree with Hendrickson et al (2018) who found innovation to have positive impact on business growth in Australia. Hence, the importance of innovation in enhancing value addition has also been discussed by several scholars including Tello (2017). Futhermore, interviewees show that "Innovation is one of the most crucial business strategies that the sugarcane industry should exploit in order to protect their market share" and "The Zimbabwean macroeconomic environment has been very unstable for quite some time now and innovation has remained one of the survival tactics to sail through. Those that are good at innovation have managed to grow and establish themselves on the market, despite the host of challenges". Thus, the majority of the interviewees heralded innovation as a very equipotent strategy, both for survival as well as for growth.

FINDINGS AND RECOMMENDATIONS

FINDINGS

Herewith are the findings of the study:

- **Challenges facing the growth of sugarcane industry in Zimbabwe**

The study shows that there are several challenges hindering growth of the sugarcane industry among them lack of sufficient financial resources in supporting research and innovation. Therefore, there is no innovation taking place at Tongaat Hulett as well as the sugarcane industry even though there is a research station in the district. Interestingly, this was also noted by Rusike (2012), who found out that lack of sufficient financial resources in supporting research and innovation was among other major factors that are affecting businesses in Zimbabwe. In addition, lack of up-to-date technology was also found to be an issue in this industrial sector as noted by Zulu (2019)'s findings which found out that there is lack of access to modern technology in the sugarcane industry in Zimbabwe and hence, lack of growth at Tongaat Hulett and the sugarcane industry as well. Furthermore, this concurs with Jesús Nieto and Miles (2012) who also asserted that the importance of innovation in the survival and growth of business organisations cannot be undervalued. Moreso, the study shows that economic instability is among the challenges seriously affecting the growth at Tongaat Hulett and the sugarcane industry in addition to shortage of foreign currency. Interestingly, Zivenge and Jesythomas (2014) also highlighted the negative effect of shortage of foreign currency in the agricultural sector in Zimbabwe which sugarcane sector also falls. Thus, the issue of foreign currency shortages in Zimbabwe has been cited by several scholars including Chandiposha (2013) as a stumbling block in promoting innovation and technology as this process also involves buying equipment from outside the country. Other issues which came out of this study, and which is hindering promotion of innovation is inflation and currency instability among the main challenges hindering growth in the sugarcane industry in addition to policy in consistence among the major challenges hindering growth in the sugarcane industry. This is also supported by Zivenge and Jesythomas (2014), who highlighted that the detrimental role played by policy inconsistencies on the growth of businesses in Zimbabwe is huge as the financial sector is also failing to provide sufficient and cost effective loans that are needed to expand and upgrade their production facilities and these results are in line with Chisango and Tichakunda (2018), who underscored the need to sufficiently finance the agricultural sector in order to ensure food security in Zimbabwe.

- **The existence of innovation in the sugarcane industry in Zimbabwe**

The findings show that there is no significant innovation in the sugarcane industry including Tongaat Hulett. Yet, innovation helps to increase sales by capturing larger market share through producing quality products. In addition, innovation increases cost efficiency as well as improving value addition, which results in profitability. This is in line with Monge-González and Hewitt (2010), who asserted that the crucial role played by innovation in enhancing profitability is not questionable. In addition, these findings also agree with Hendrickson et al (2018) who found innovation to have positive impact on business growth in Australia. Hence, the importance of innovation in enhancing value addition has also been discussed by several scholars including Tello (2017).

RECOMMENDATIONS

It is worth noting that the investment in innovation in the sugarcane industry in Zimbabwe will enhance sugarcane industry's performance as stated below:

- **Sugarcane breeding**

Sugarcane breeding is a well-established practice in the sugarcane industry and has a long and successful history in the world. Accordingly, notable leading sugarcane breeding centres were established in West Indies Sugarcane Central Breeding Station (based in Barbados, but servicing the whole Caribbean),

MSIRI (based in Mauritius), and indirectly SASRI (based in South Africa) but servicing many neighbouring Southern African countries), with the focusing of breeding sugarcane varieties with high yields and sucrose, and with high fibre content for producing electricity (Sica, 2020). Likewise, early maturing, high sucrose sugar cane variety is now taking the center stage (Shezi, 2017), in addition to content characteristics, disease resistance (such as to ratoon stunting disease, yellow spot and yellow leaf syndrome) and improved agronomy characteristics (rapid covering of the inter-row, erectness, tolerance to drought and freezes, and optimal nutrient uptake) with Zimbabwe sugar industry needs to invest in (Glaz 2003). Although sugarcane breeding will not yield immediate success to the Zimbabwean sugarcane industry, but the benefits are huge with time (Tandzi and Mutengwa, 2020). Additionally, it is worth noting that developing a new variety takes time (13-15 years) and the uptake of improved varieties tends to be slow due to high replanting costs hence, the need be patient (Glaz 2003).

- **Agricultural practices in sugarcane production**

Principle areas of attention with regard to agricultural practices in sugarcane production are:

• Crop rotation

In most countries' sugarcane is grown as a mono-crop without any crop rotation and research Glaz (2003). This has shown long term adverse effects of changes in soil pH, loss of organic matter and adverse changes in soil biota which is attributed to lack of crop rotation. In addition, to crop rotation, multi cropping leads to sound use of land and reduces dependency on single crop income and should be implemented in Zimbabwe on a large scale in order to improve yields and profits as well as much needed foreign currency (Kahan, 2008; www.fao.org).

• Crop protection

Application of chemical-based pesticides and insecticides in sugarcane production is quite common although, application levels seem to be relatively moderate compared to some other crops (Kahan, 2008). Thus, the total costs of chemical protection per hectare is quite considerable and associated with health risks and environmental damage and thus, in countries like Australia, India and South Africa the use of bio-pesticides and biological control is a major research topic to develop cheaper alternatives that are environmentally friendly, and Zimbabwe is no exception (Glaz, 2003).

• Water management

Sugarcane is grown in relatively tropical or sub-tropical climate and the crop has been adapted to grow both in high rainfall areas and in desert conditions (Srivastava and Rai, 2012; www.sucrose.com). In desert condition, the crop entirely depends on irrigation and amount of crop grown is dependent on available irrigation water and thus, sugarcane fields must be designed efficiently to hold the requisite amount of water as too low or too high affects growth and hence the need for research in this area in Zimbabwe (Srivastava and Rai, 2012; Zhao and Li, 2015).

• Soil management

Maintaining soil fertility, avoiding soil compaction and reducing the incidence of soil erosion are the important aspects of soil management in sugarcane production (www.dpi.nsw.gov.au; www.fao.org). The latter is in particular a problem in hilly areas and does not only affect the soil quality of the sugarcane fields, but also creates huge negative externalities downstream as rivers and lakes get filled up with sediment as being witnessed in Zimbabwe (Swallow et al, 2001; Bulte and Ruben, 2007).

• Nutrient management

Nitrogen and phosphorus are crucial nutrients for an adequate development of sugarcane, while at the same time they can cause environmental pollution when not adequately managed (Bulte and Ruben, 2007; Skocaj et al, 2013; Schausberger, 2017). Thus, the re-use of trash, application of micro-organisms, and optimization of nutrient application by utilization of spectroscopy tools for assessing nutrient status in the cane in real time and adapting the management practices accordingly has been reported to be reducing environmental pollution and something that could be introduced in Zimbabwe as well (Glaz, 2003; Abdel-Shafy and Mans, 2018).

• Mechanization

The introduction of mechanized harvesting is usually steered by cost benefit considerations and in countries where labour is relatively cheap and capital expensive, harvesting is still done predominantly by hand (Schmitz and Moss, 2015; Gallardo and Sauer, 2018; www.fao.org). That said, topographic characteristics also influence the choice for a human cutter instead of machinery (https://pubs.usgs.gov). Likewise, most of the machines used by sugarcane producers have been developed by the private agricultural machinery industry and thus, the role of sugarcane research has usually been limited to looking at how best machinery can be used in the field and what type of

adjustments are needed (eg. the optimal width between sugarcane rows) (Bulte and Ruben, 2007; Skocaj et al, 2013; Schausberger, 2017). In consequence, innovation in this domain is taking place especially in Brazil and Australia (Ridge 2003) and thus, new developments are focusing on refinement of cane transport equipment, harvesting machinery, trash management to optimize nutrient application and of cutting for replanting and will be ideal for Zimbabwe too (Glaz, 2003; Abdel-Shafy and Mans, 2018).

- **Burning of sugarcane**

Burning of sugarcane prior to harvesting is still a common practice in many countries however, this practice is under attack given that some countries have introduced legislation that forbid this practice because the smoke it causes is a health hazard and causes environmental pollution and there is evidence that burning often negatively affects the quality of the sugarcane (Bulte and Ruben, 2007; Skocaj et al, 2013; Schausberger, 2017; Abdurrahman et al, 2020; www.fao.org). Currently research is taking place to further optimize the use of the trash either for energy co-generation or in the field as a natural fertilizer and this can be done in Zimbabwe too (Bulte and Ruben, 2007; Skocaj et al, 2013; Schausberger, 2017).

- **Optimization Models and Geographic Information Systems**

A better understanding of sugarcane growth has been brought upon by the use of models and APSIM-Sugarcane and CANEGROW are models successfully used for estimating yields and making irrigation decisions not only in Australia and South Africa where they were developed but also in other countries like Mauritius (Bulte and Ruben, 2007; Skocaj et al, 2013; Schausberger, 2017; Peng et al, 2020). Thus, successful application of GIS tools has been reported in Argentina, Cuba and Thailand and something that could be done in Zimbabwe as well even though focus is on innovation (Glaz 2003; Bulte and Ruben, 2007; Skocaj et al, 2013).

- **The provision of sufficient foreign currency**

It is recommended that the government should provide sufficient foreign currency to enable the sugarcane industry to implement innovative and growth strategies such as the introduction of nutritional and energy needs of the country. In addition, the sugarcane industry needs foreign currency for importing technologies like adaptable sugar plants that support both sugar and ethanol production as well as supporting value addition in sugar by-products; packaged fertilizer from filter cake, bottled drinking water, pharmaceutical and industrial base solvents from ethanol, packaging board from bagasse and maximization of power generation.

- **Stabilizing the operating environment**

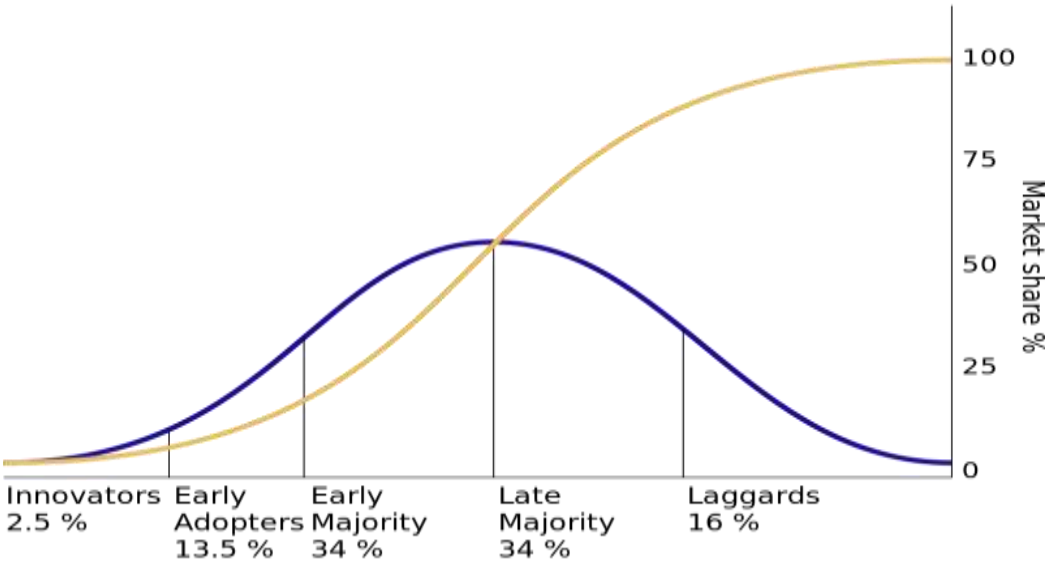
The government should stabilize the operating environment to support the sustainability and growth of the sugarcane industry. Thus, the government should implement policies that will reduce the rate of inflation and stabilize the exchange rate so that the sugarcane industry is able to plan and preserve its profits. Furthermore, stabilizing the operating environment gives investor confidence in the sugarcane sector. Thus, policy consistency would also allow sugarcane firms to plan and predict changes in the operating environment thus enabling innovation and growth in the sector.

- **The Theoretical Framework used in this study**

The main tenets of four diffusion theories and models are innovation diffusion theory, concerns-based adoption model, technology acceptance model and the chocolate model (Straub, 2009). Thus, this study adopted and discusses in detail the diffusion of innovation theory, which describes the pattern and speed at which new ideas, practices, or products spread through a population (Sherry and Gibson, 2002; Sahin, 2006). In fact, diffusion of innovation (DOI) theory was developed by E.M. Rogers in 1962 and is one of the oldest social science theories in the whole world. In fact, DOI originated in communication to explain how, over time, an idea or product gains momentum and diffuses (or spreads) through a specific population or social system (Sherry and Gibson, 2002; Sahin, 2006; Straub, 2009). Thus, the innovation theory of profit hypothesizes that the entrepreneur gains profit if his innovation is successful either in reducing the overall cost of production or increasing the demand for his product (Rogers 1995; Sahin, 2006; Straub, 2009). Consequently, the main players in the diffusion of innovation theory are as follows: innovators, early adopters, early majority, late majority, and laggards (Rogers 1995; Straub, 2009). Likewise, the theory of innovation diffusion has four characteristics namely, the innovation itself, the nature of the communication channels, the passage of time, and the social system through which the innovation diffuses (Rogers 1995; Sahin, 2006).

- **The need to adopt diffusion on innovation theory in the sugarcane industry**

The Diffusion of Innovation theory



The above-mentioned theory outlines five different categories of adopters and it also shows how adoption decisions are taken in waves. These adopter categories are as follows:

- **Innovators**

Innovators are the first to try new ideas and technologies and they are also invested in new concepts and innovators are also adventurous and risk-taking and are also motivated by the idea of being change agents (Sherry and Gibson, 2002; Sahin, 2006). Thus, innovators tend to be financially well off and tend to operate in more cosmopolitan social circles (Rogers 1995). Accordingly, innovators comprise roughly 2.5% of the population in any given environment no matter the economic situation (Rogers 1995; Sahin, 2006).

- **Early Adopters**

Early adopters provide opinion leadership, and they want to be the first because they want to take a leading position as role models and trendsetters (Straub, 2009). Accordingly, these opinion leaders embrace the opportunity for change (Sahin, 2006). In fact, the segment tends to be integrated into the local social system, and they have also social status and can exercise concentrated influence in their area (Straub, 2009). Thus, the early adopters comprise roughly 13.5% of the population (Rogers 1995; Straub, 2009).

- **Early Majority**

The early majority are very social, and they have deliberate contact with peers (Rogers 1995; Straub, 2009). Furthermore, innovators are comfortable with changing their behaviour but only in so far as it improves their lifestyle and/or productivity (Rogers 1995; Straub, 2009). In addition, they want confirmed ideas and technology and so they need new ideas and technology to be vetted by peers and colleagues (Rogers 1995). Thus, the early majority comprises roughly of 34% of the population (Rogers 1995; Straub, 2009).

- **Late Majority**

The late majority are skeptical and they tend to adopt ideas later than the average person in a given social system (Rogers 1995). When they do adopt ideas, it's often out of social or economic necessity. In other words, because they are pressured by system norms and thus, the late majority comprises roughly of 34% of the population (Rogers 1995; Straub, 2009).

- **Laggards**

Laggards tend to be older, and they are focused on traditions and often have limited socializing and

since they are more-or-less only in contact with family and close friends, they are not as pressured to adapt (Straub, 2009). Thus, they view innovators and innovations with suspicion and hence, they adopt very late (Rogers 1995; Straub, 2009). Furthermore, original innovators may well consider the innovations obsolete and hence, laggards comprise roughly 16% of the population (Rogers 1995; Straub, 2009).

CONCLUSION

In conclusion, the literature review and this study have shown that more value can be derived from the Zimbabwe sugar industry in order to improve its overall growth and it was also noted that by-products will create value for the sugarcane industry like in developed economies such as Australia. Thus, whilst ethanol is produced in the country, it is clear that various benefits of enriching carbon dioxide and acetone, ethylene and acetic acids have not been followed through in Zimbabwe and hence the need for researches of this nature to see if they can play a role in developing the Zimbabwean economy as already shown in this study in its findings despite challenges the sugarcane industry is facing. For example, press mud is discharged as waste and no value addition is done on it in Zimbabwe. Thus, a lot more can be done in power co-generation to attract the required investment and improve electricity generation. In consequence, the challenges bedevilling the sugarcane industry in particular and the Zimbabwean economy at large are almost similar to some Southern Africa countries but niche solutions to problems need to be created. Hence, it is worth noting that sugar as a business is no longer lucrative as it used to be but benefits from innovation are huge as the case with developed economies such as South Africa, Brazil, India and Australia just to name a few.

REFERENCES

1. Aalbers, R. and Whelan, E., 2021. Implementing digitally enabled collaborative innovation: A case study of online and offline interaction in the German automotive industry. Creativity and Innovation Management, 30(2), pp.368-383.
2. Abbey, A., & Dickson, J. W. (1983). R&D work climate and innovation in semiconductors. Academy of Management Journal, 26(2), 362-368.
3. Abdel-Shafy, H. I., & Mansour, M. S. (2018). Solid waste issue: Sources, composition, disposal, recycling, and valorization. Egyptian journal of petroleum, 27(4), 1275-1290.
4. Abdurrahman, M. I., Chaki, S., & Saini, G. (2020). Stubble burning: Effects on health & environment, regulations and management practices. Environmental Advances, 2, 100011.
5. Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. Journal of personality and social psychology, 45(2), 357.
6. Amabile, T. M. (1996). Creativity and innovation in organizations (Vol. 5). Boston: Harvard Business School.
7. Amabile, T. M. (1998). How to kill creativity (Vol. 87). Boston, MA: Harvard Business School Publishing.
8. Amabile, T. M., & Gryskiewicz, N. D. (1989). The creative environment scales: Work environment inventory. Creativity research journal, 2(4), 231-253.
9. Amabile, T., & Gryskiewicz, S. S. (1987). Creativity in the R & D laboratory. Center for Creative Leadership.
10. Anderson, S. P., De Palma, A., & Thisse, J. F. (1992). Discrete choice theory of product differentiation. MIT press.
11. Aronson, D. (2008). Hyperglycemia and the pathobiology of diabetic complications. Cardiovascular diabetology: Clinical, metabolic and inflammatory facets, 45, 1-16.
12. Attewell, A. (2003). Throwing light on Florence Nightingale: Of lamps and lanterns. International History of Nursing Journal, 7(3), 94.
13. Auer, M. E., & Tsiatsos, T. (Eds.). (2018). Interactive Mobile Communication Technologies and Learning: Proceedings of the 11th IMCL Conference (Vol. 725). Springer.
14. Barrett, L. F., Adolphs, R., Marsella, S., Martinez, A. M., & Pollak, S. D. (2019). Emotional expressions reconsidered: Challenges to inferring emotion from human facial movements. Psychological science in the public interest, 20(1), 1-68.
15. Behera, S. K., Kim, J. H., Lee, S. Y., Suh, S., & Park, H. S. (2012). Evolution of

'designed'industrial symbiosis networks in the Ulsan Eco-industrial Park:'research and development into business' as the enabling framework. Journal of Cleaner Production, 29, 103-112.

16. Berglund, H. (2007). Opportunities as existing and created: A study of entrepreneurs in the Swedish mobile internet industry. Journal of Enterprising Culture, 15(03), 243-273.

17. Bowler, P. (1965, November). The application of a cycloconverter to the control of induction motors. In Proceedings of IEE Conference on Power Applications of Controllable Semiconductor Devices (Vol. 17, pp. 137-145).

18. Brand, A. (1998). Knowledge management and innovation at 3M. Journal of knowledge management, 2(1), 17-22.

19. Braunerhjelm, P. (2010). Entrepreneurship, Innovation and Economic Growth-past experience, current knowledge and policy implications.

20. Bulte, E., & Ruben, R. (Eds.). (2007). Development economics between markets and institutions: Incentives for growth, food security and sustainable use of the environment (Vol. 4). Wageningen Academic Publishers.

21. Chandiposha, M. (2013). Potential impact of climate change in sugarcane and mitigation strategies in Zimbabwe: African Journal of Agricultural Research Review: Academicjournals.org

22. Chigunhah, B.R., Svotwa, E., Munyoro, G., Govere, I. (2020), The determinants of credit demand among farmers in Hurungwe district of Mashonaland West province in Zimbabwe. Journal of Economics and International Finance, 12, 74-83.

23. Chingarande, D., Mugano, G., Chagwiza, G. and Hungwe, M., 2020. Zimbabwe Market Study: Masvingo Province Report.

24. Chisango, T. F. F., & Tichakunda, F. (2018). Challenges and prospects of Zimbabwe's command farming in unlocking the country's smallholder agricultural economy. Int. J. Agric. Econ, 3(4), 76-82.

25. Cook, N. D. (1998). Born to die: disease and New World conquest, 1492-1650 (Vol. 1). Cambridge University Press.

26. Cummings, L. (1965). Organizational climates for creativity. Academy of Management Journal, 8(3), 220-227.

27. Curtin, D. (1993). Constitutional Structure of the Union: A Europe of Bits and Pieces, The. Common Market L. Rev., 30, 17.

28. Davila, J., Fridman, L., & Poznyak, A. (2006, June). Observation and identification of mechanical systems via second order sliding modes. In International Workshop on Variable Structure Systems, 2006. VSS'06. (pp. 232-237). IEEE.

29. De Mendonca, T., & Zhou, Y. (2019). What does target ecological sustainability mean for company financial performance? Business Strategy and the Environment, 28(8), 1583-1593.

30. Dearing, J. W. (2009). Applying diffusion of innovation theory to intervention development. Research on social work practice, 19(5), 503-518.

31. Deepchand, K. (2005, October). Sugar cane bagasse energy cogeneration–Lessons from Mauritius. In parliamentarian forum on energy legislation and sustainable development, Cape Town, South Africa (Vol. 10, p. 2005).

32. Delbecq, A. L., & Mills, P. K. (1985). Managerial practices that enhance innovation. Organizational dynamics, 14(1), 24-34.

33. Donaldson, T. and Walsh, J.P., 2015. Toward a theory of business. Research in Organizational Behavior, 35, pp.181-207.

34. Drucker, P. F. (2006). Classic Drucker: essential wisdom of Peter Drucker from the pages of Harvard Business Review. Harvard Business Press.

35. Dubb, A. (2013). The rise and decline of small-scale sugarcane production in South Africa: A Historical Perspective: Institute for Poverty, Land and Agrarian Studies (Plaas): Working Paper 28

36. Dyczkowska, J., & Dyczkowski, T. (2018). Democratic or autocratic leadership style? Participative management and its links to

rewarding strategies and job satisfaction in SMEs. Athens Journal of Business & Economics, 4(2), 193-218.

37. Engelberg, S. (2009, May). The effect of increasing the sampling rate on the effectiveness of the matched filter. In 2009 IEEE Instrumentation and Measurement Technology Conference (pp. 1453-1457). IEEE.

38. Erdil, A., & Erbıyık, H. (2019). The importance of benchmarking for the management of the firm: evaluating the relation between total quality management and benchmarking. Procedia Computer Science, 158, 705-714.

39. Feuer, R., Ruller, C. M., An, N., Tabor-Godwin, J. M., Rhoades, R. E., Maciejewski, S., ... & Whitton, J. L. (2009). Viral persistence and chronic immunopathology in the adult central nervous system following Coxsackievirus infection during the neonatal period. Journal of virology, 83(18), 9356-9369.

40. Ford, C. M., Gioia, D. A., & Gioia, D. A. (Eds.). (1995). Creative action in organizations: Ivory tower visions and real-world voices. Sage.

41. Gallardo, R. K., & Sauer, J. (2018). Adoption of labor-saving technologies in agriculture. Annual Review of Resource Economics, 10, 185-206.

42. George, G., Zahra, S. A., & Wood Jr, D. R. (2002). The effects of business–university alliances on innovative output and financial performance: a study of publicly traded biotechnology companies. Journal of business Venturing, 17(6), 577-609.

43. Glaz, B. (2003). Integrated crop management for sustainable sugarcane production: recent advances. International sugar journal, 105, 175-186. globalpressjournal.com;

44. Gopalakrishnan, C., & Nahan, M. (1977). Economic Potential of Bagasse as an Alternate Energy Source: The Hawaiian Experience. In Agriculture and energy (pp. 479-488). Academic Press.

45. Griggs, P. (2004). Improving agricultural practices: Science and the Australian sugarcane grower, 1864–1915. Agricultural history, 78(1), 1-33.

46. Gunjal, B. and Gunjal, A., 2013. Water conservation in sugar industry. Nature Environment and Pollution Technology, 12(2), p.325.

47. Heathfield, S. M. (2020). What is resistance to change. Definition & Examples of Resistance to Change Updated, 6.

48. Hendrickson, J. R., Vangala, S., Dass, C., Gibson, R., Goldsmith, J., Leedy, K., ... & Guo, J. (2018). Coupling of epsilon-near-zero mode to gap plasmon mode for flat-top wideband perfect light absorption. ACS Photonics, 5(3), 776-781.

49. Hidzir, N. S., Som, A. S., & Abdullah, Z. (2014, August). Ethanol production via direct hydration of ethylene: A review. In International conference on global sustainability and chemical engineering (ICGSE).

50. Higgins, J. M. (1995). How Effective Innovative Companies Operate—Lessons from Japanese Strategy. Creativity and Innovation Management, 4(2), 110-119.

51. Howell, L. L. (2013). Compliant mechanisms. In 21st Century Kinematics: The 2012 NSF Workshop (pp. 189-216). Springer London. https://apps.fas.usda.gov). https://world-nuclear.org).

52. Inarkar, M. B., & Lele, S. S. (2012). Extraction and characterization of sugarcane peel wax. International Scholarly Research Notices, 2012.

53. Iryani, E. (2012). Pragmatics; the Analysis of Polite Language in Maxim Theories. isosugar.org;

54. Johnson, F.X., Batidzirai, B., Iiyama, M., Ochieng, C.A., Olsson, O., Mofor, L. and Gasparatos, A., 2020. Enabling Sustainable Bioenergy Transitions in Sub-Saharan Africa: Strategic Issues for Achieving Climate-Compatible Developments. In Sustainability Challenges in Sub-Saharan Africa I (pp. 51-80). Springer, Singapore.

55. Johnson, G., & Scholes, K. (1984). Six Myths About Strategy Making: And What To Do

About Them. Management Research News, 7(4), 21-26.

56. Jones, G., & McFadzean, E. S. (1997). How can Reboredo foster creativity in her current employees and nurture creative individuals who join the company in the future?. Harvard Business Review, 75(5), 50.

57. Kahan, D. M. (2008). Cultural cognition as a conception of the cultural theory of risk. HANDBOOK OF RISK THEORY, S. Roeser, ed., Forthcoming, Harvard Law School Program on Risk Regulation Research Paper, (08-20).

58. Keys, P. (1989). OR as technology: Some issues and implications. Journal of the Operational Research Society, 40(9), 753-759.

59. Khadka, K., & Maharjan, S. (2017). Customer satisfaction and customer loyalty. Centria University of Applied Sciences Pietarsaari, 1(10), 58-64.

60. Kimberly, J. R., & Evanisko, M. J. (1981). Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. Academy of management journal, 24(4), 689-713.

61. Kumar, V., & Chopra, A. K. (2016). Effects of sugarcane pressmud on agronomical characteristics of hybrid cultivar of eggplant (Solanum melongena L.) under field conditions. International Journal of Recycling of Organic Waste in Agriculture, 5, 149-162.

62. Larson, B. M. (2005). The war of the roses: demilitarizing invasion biology. Frontiers in Ecology and the Environment, 3(9), 495-500.

63. Law, J. (1993). Organising modernity: Social ordering and social theory. John Wiley & Sons.

64. Laws, B. (2010), Fifty Plants that Changed the Course of History: Newton Abbot, David & Charles

65. Mamvura, T. A., & Danha, G. (2020). Biomass torrefaction as an emerging technology to aid in energy production. Heliyon, 6(3), e03531.

66. Mbohwa, C., & Fukuda, S. (2003). Electricity from bagasse in Zimbabwe. Biomass and Bioenergy, 25(2), 197-207.

67. McNeill, W,. H. (1984), Human Migration in Historical Perspective: Vol, 10. No.1, pp 1-18. Population and Development Review: Population Council

68. Misra, V., Solomon, S., Mall, A.K., Abid, M., Abid Ali Khan, M.M. and Ansari, M.I., 2022. Drought Stress and Sustainable Sugarcane Production. In Microbial BioTechnology for Sustainable Agriculture Volume 1 (pp. 353-368). Springer, Singapore.

69. Mlambo, A., S. and Pangeti, E., S. (1996). The political economy of the sugar industry in Zimbabwe 1920-1990: University of Zimbabwe

70. Monge-González, R. and Hewitt, J., 2010. Innovation, R&D and productivity in the Costa Rican ICT sector: A case study.

71. Morgan, J. P. (1991). Abnormal intracellular modulation of calcium as a major cause of cardiac contractile dysfunction. New England Journal of Medicine, 325(9), 625-632.

72. Munyoro, W. (2014). A critical evaluation of corporate rebranding exercise: A case study of the Telecel Zimbabwe (2012-2013) (Doctoral dissertation).

73. Muromo, F. (2017). An assessment of the transformation of Mkwasine Sugar Estate after land reform: the tensions and conflicts (Doctoral dissertation).

74. Naghashyan, H. Z., Hakobyan, A. R., & Martirosyan, A. A. (2018). A new disease in fish farms of Armenia. Annals of Agrarian Science, 16(4), 410-412.

75. Naqvi, S. M. M. R. (2020). Employee voice behavior as a critical factor for organizational sustainability in the telecommunications industry. PloS one, 15(9), e0238451.

76. Ndeketeya, A., Rusere, F., Svubure, O., Gwatibaya, S., Soropa, G. and Mashonganyika, J., 2014. Drip irrigation as a potential alternative to furrow irrigation in sugar-cane production-a case of the Lowveld Estate, Zimbabwe. International Journal of

Agricultural Policy and Research, 2(1), pp.26-32.

77. Nieuwenhuis, P., & Wells, P. (2003). The automotive industry and the environment. Woodhead Publishing.

78. Nowacka, A., & Rzemieniak, M. (2022). The impact of the VUCA environment on the digital competences of managers in the power industry. Energies, 15(1), 185.

79. Nyathi, C. (1999). The Zimbabwe Sugar Association Experiment Station: Major agronomy research thrusts for the period 1966-2000. Zimbabwe Science News, 33(4), 107-108.

80. Nyström, H. (1979). Creativity and innovation. Chichester [Eng.]; New York: Wiley.

81. Paolillo, J. G., & Brown, W. B. (1978). How organizational factors affect R&D innovation. Research management, 21(2), 12-15.

82. Paolillo, J. G., & Brown, W. B. (1978). How organizational factors affect R&D innovation. Research management, 21(2), 12-15.

83. Park, H. and Shea, P., 2020. A Review of Ten-Year Research through Co-citation Analysis: Online Learning, Distance Learning, and Blended Learning. Online Learning, 24(2), pp.225-244.

84. Paungfoo-Lonhienne, C,. Rentsch, D,. Robatzek, S,. Webb, R,. I. (2010). Turning the Table: Plants Consume Microbes as a Source of Nutrients: Vol. 5(7), PubMed

85. Paungfoo-Lonhienne, C., Visser, J., Lonhienne, T.G. and Schmidt, S., 2012. Past, present and future of organic nutrients. Plant and Soil, 359(1), pp.1-18.

86. Pelz, D. C. (1956). Some social factors related to performance in a research organization. Administrative science quarterly, 310-325.

87. Pina, S., Oliveira, J. M., & Reis, R. L. (2015). Natural-based nanocomposites for bone tissue engineering and regenerative medicine: A review. Advanced Materials, 27(7), 1143-1169.

88. Price, E. (2019). Slow Dans.

89. Reilly, P. A. (1998). Balancing flexibility—meeting the interests of employer and employee. European journal of work and organizational psychology, 7(1), 7-22.

90. Ridge, M. (2003). Moral non-naturalism.

91. Ringberg, T., Reihlen, M. and Rydén, P., 2019. The technology-mindset interactions: Leading to incremental, radical or revolutionary innovations. Industrial Marketing Management, 79, pp.102-113.

92. Rogers, C. S. (1983). Sublethal and lethal effects of sediments applied to common Caribbean reef corals in the field. Marine Pollution Bulletin, 14(10), 378-382.

93. Rogers, E. M. (1995). Lessons for guidelines from the diffusion of innovations. The Joint Commission journal on quality improvement, 21(7), 324-328.

94. Rusike, J. (2012). Africa RISING Research framework.

95. Ryan, G. (2018). Introduction to positivism, interpretivism and critical theory. Nurse researcher, 25(4), 41-49.

96. Sahin, I. (2006). Instructional computer use by COE faculty in Turkey: Application of Diffusion of Innovations Theory. Iowa State University.

97. Sahu, O., 2018. Assessment of sugarcane industry: Suitability for production, consumption, and utilization. Annals of Agrarian Science, 16(4), pp.389-395.

98. Salusjärvi, L., Havukainen, S., Koivistoinen, O., & Toivari, M. (2019). Biotechnological production of glycolic acid and ethylene glycol: current state and perspectives. Applied microbiology and biotechnology, 103, 2525-2535.

99. Sandrey, R., & Vink, N. (2007, December). Future prospects for African sugar: sweet or sour?. In public conference on Global Sugar Markets, Policies and Reform Options—International Food Policy Research Institute—Washington at website:—http://www. ifpri. org/events/conferences/2007/20070601sugar/SandreyVink. pdf.

100. Santamaría, L., Nieto, M. J., & Miles, I. (2012). Service innovation in manufacturing

firms: Evidence from Spain. Technovation, 32(2), 144-155.

101. Saunders, A. M., Albertsen, M., Vollertsen, J., & Nielsen, P. H. (2016). The activated sludge ecosystem contains a core community of abundant organisms. The ISME journal, 10(1), 11-20.

102. Saunders, P. T. (1980). An introduction to catastrophe theory. Cambridge University Press.

103. Schausberger, P., & Peneder, S. (2017). Non-associative versus associative learning by foraging predatory mites. BMC ecology, 17, 1-8.

104. Schmitz, A., & Moss, C. B. (2015). Mechanized agriculture: Machine adoption, farm size, and labor displacement.

105. Scully, J. A., Kirkpatrick, S. A., & Locke, E. A. (1995). Locus of knowledge as a determinant of the effects of participation on performance, affect, and perceptions. Organizational Behavior and Human Decision Processes, 61(3), 276-288.

106. Sherry, L., & Gibson, D. (2002). The path to teacher leadership in educational technology. Contemporary issues in technology and teacher education, 2(2), 178-203.

107. Shezi, S. N. (2017). Agronomic Performance of Sugarcane Varieties Derived from Tissue Culture (NovaCane ®) and Conventional Seedcane under Rainfed Conditions.

108. Sica, P., Carvalho, R., Das, K. C., & Baptista, A. S. (2020). Biogas and biofertilizer from vinasse: making sugarcane ethanol even more sustainable. Journal of Material Cycles and Waste Management, 22, 1427-1433.

109. Siegel, S. M., & Kaemmerer, W. F. (1978). Measuring the perceived support for innovation in organizations. Journal of Applied Psychology, 63(5), 553.

110. Sikuka, K. (2017). Is there a link between Democracy and Development in Africa?. conflict trends, 2017(3), 3-10.

111. Skocaj, D. M., Everingham, Y. L., & Schroeder, B. L. (2013). Nitrogen management guidelines for sugarcane production in Australia: can these be modified for wet tropical conditions using seasonal climate forecasting? Springer Science Reviews, 1(1-2), 51-71.

112. Srivastava, A. K., & Rai, M. K. (2012). Sugarcane production: Impact of climate change and its mitigation. Biodiversitas Journal of Biological Diversity, 13(4).

113. Steinberg, L. (2017). A social neuroscience perspective on adolescent risk-taking. In Biosocial Theories of Crime (pp. 435-463). Routledge.

114. Steinkraus, K. H. (1992). Lactic acid fermentations. Applications of biotechnology to traditional fermented foods, 43-51.

115. Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. Review of educational research, 79(2), 625-649.

116. Swallow, J., Koteja, P., Carter, P., & Garland, T. (2001). Food consumption and body composition in mice selected for high wheel-running activity. Journal of Comparative Physiology B, 171, 651-659.

117. Tandzi, N. L., & Mutengwa, S. C. (2020). Factors affecting yield of crops. Agronomy–Climate Change and Food Security. London: IntechOpen.

118. Tedla, T. B. (2016). The impact of organizational culture on corporate performance (Doctoral dissertation, Walden University).

119. Tello, M. D. (2017). Innovation and productivity in services and manufacturing firms: The case of Peru: Mario D. Tello. Cepal Review, 2017(121), 69-86.

120. Tongaat Hulett Zimbabwe financial year results, 2015

121. Trejo-Pech, C.J., DeLong, K.L., Lambert, D.M. and Siokos, V., 2020. The impact of US sugar prices on the financial performance of US sugar-using firms. Agricultural and Food Economics, 8(1), pp.1-17.

122. Tshuma, M. C. (2022). The impact of socio-economic factors on livestock farmers knowledge and skills in the Eastern Cape Province: The case of Marselle farmers. Journal of Development and Agricultural Economics, 14(2), 41-49. unctad.org

123. USDA ERS. (2018). Sugar and sweeteners yearbook tables. Retrieved July 19, 2018, from United States Department of Agriculture. Economic Research Service. ustr.gov

124. Valente, F. and Laurini, M., 2021. Pre-harvest sugarcane burning: A statistical analysis of the environmental impacts of a regulatory change in the energy sector. Cleaner Engineering and Technology, 4, p.100255.

125. Van Niekerk, B. D. H. (1981). By-products of the sugar industry as animal feeds. South African Journal of Animal Science, 11(2), 119-137.

126. Von Hippel, E. (2005). Democratizing innovation: The evolving phenomenon of user innovation. Journal für Betriebswirtschaft, 55, 63-78.

127. Von Hippel, P.T., 2005. Mean, median, and skew: Correcting a textbook rule. Journal of statistics Education, 13(2).

128. Vries, E. D. (1969). The Agro-Economic Survey of Indonesia. Bulletin of Indonesian Economic Studies, 5(1), 73-77.

129. Vuyyuru, M., Sandhu, H.S., McCray, M.J., Raid, R.N. and Erickson, J.E., 2019. Effects of nitrogen fertilization and seed piece applied fungicides on establishment, tiller dynamics, and sucrose yields in successively planted sugarcane. Agronomy, 9(7), p.387.

130. Wang, L., Cho, D. W., Tsang, D. C., Cao, X., Hou, D., Shen, Z., ... & Poon, C. S. (2019). Green remediation of As and Pb contaminated soil using cement-free clay-based stabilization/solidification. Environment international, 126, 336-345. www.agmrc.org, www.fao.org, www.zera.co.zw; www4.unfccc.int

131. Zahniser, S., Kennedy, L., Nigatu, G., & McConnell, M. (2016). A new outlook for the U.S.-Mexico sugar and sweetener market (No. SSSM-335-01; p. 53)

132. Zeleza, T. (1988). African sugar in the world market. Journal of Eastern African Research & Development, 18, 1-23.

133. Zivenge, E.; Jesythomas, K. Impact of agriculture input support programme on economic benefit in Zimbabwe. International Journal of Commerce and Business Managemeny, 201t, vol. 7(1), p. 210–214.

134. Zulu, N., S., Sibanda, S. and Tlali, B., S. (2019). Agriculture Article Factors Affecting Sugarcane Production by Small-Scale Growers in Ndwedwe Local Municipality, South Africa: MDPI

135. Zuurbier, P. and Van de Vooren, J., 2008. Introduction to sugarcane ethanol contributions to climate change mitigation and the environment. Sugarcane ethanol, p.19.