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CRITICAL EVALUATION OF GENETICALLY MODIFIED ORGANISMS AS AN INTERVENTION STRATEGY IN AGRIBUSINESS SECTOR IN KENYA WITHIN THE CONTEXT OF CLIMATE CHANGE

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ABSTRACT

Climate change has negative effects on crop yields, nutritional quality, livestock productivity, human health and the rate of economic growth. This has exacerbated food and nutrition insecurity in Kenya, hence the cabinet approval of genetically modified crops that attracted praise and protestations in equal measure. This study using a meta-analysis approach therefore sought to detect gaps in the phenomenon of genetically modified organisms as an intervention strategy in agribusiness sector, governmental regulatory framework, agripreneurship competencies and their impact on food security in Kenya. The study revealed that Agriculture remains a pillar to Kenya's economy. The study also established that climate change complicates Kenya's long-term aspiration of attaining nutrition and food security, with 4.2 million people facing acute hunger in year 2022, while simultaneously wasting about 5.2 tonnes of food every year. Further, studies on genetically modified organisms have reported conflicting results on effect on human health, ethical consideration, ownership of technology, seed sovereignty and adequacy of capacity to test for quality standards. This study argues that there is inadequate data to support cultivation and importation of genetically modified food crops as a hunger intervention measure in Kenya. Seedlings generated through biotechnology innovations not only negate the need to produce in harmony with nature, but are also a threat to food security through patents ownership by multinationals. This implies that the premise upon which genetically modified organisms were approved in Kenya is faulty. The study concludes that vulnerable people experiencing hunger in Kenya is due to supply chain failure in agribusiness sector, rather than lack of food in the country. The study therefore recommends that discussions about food insecurity in Kenya should focus on how to improve infrastructure, enhancement of agripreneurship competencies along the whole food value chain including seed, agricultural production and distribution factors. There is also need to shift towards irrigation as opposed to over reliance on rain fed agriculture. The study has also suggested the need to use an integrated model and some propositions to be tested as hypotheses to generate data to facilitate evidence based solutions to enhance agribusiness sector productivity, food and nutrition security in Kenya.

Key words: Climate Change, Agripreneurship, Agribusiness, Genetically Modified Organisms

INTRODUCTION

Report on the state of food and nutrition shows that impediments to finish hunger, food insecurity and all forms of malnutrition have been increasing (FAO, 2022; WFP, 2022). Resent research data shows that the number of people who cannot afford a healthy diet globally increased by 112 million to almost 3.1 billion in year 2022, due to rising consumer food prices as a result of the ravages of COVID-19 pandemic and disruptions in supply chain related to the conflict between Russia and Ukraine (World Bank, 2022; FAO, 2022). The situation has also been compounded by climate change caused by environmental degradation and Heat trapping greenhouse gas emissions that are believed to have resulted in 1.0 °C of global warming above the pre-industrial levels (IPCC, 2022; Beckmann, Hiete & Beck, 2021; Rohat, *et al*., 2019). This long-term shift in weather pattern has been reported to have serious implications on human health, productivity of employees, crop yields, nutrition quality of major cereals, livestock productivity and economic growth (UN, 2021; IPCC, 2019). Change in weather conditions, including rise in atmospheric temperature, extreme weather events such as droughts, heat waves, landslides and floods have therefore been identified as a hindrance towards the achievement of the objectives of the 2030 global sustainable development goals, especially those related to food and nutrition security, health and wellbeing, job creation and housing (Buonocore *et al*., 2019; Reidmiller *et al*., 2018; IPCC, 2014). For instance, negative effect of climate change on human health after exposure to extreme heat events for prolonged durations, have been reported to result in heat stroke, heat exhaustion, heat cramps and death in some cases (Sailor, Baniassadi, O'Lenick & Wilhelmi, 2019; Uejio *et al*., 2016; Holmes, Phillips & Wilson, 2016). Studies have also reported a correlation between prolonged exposure to extreme heat with a range of mental health impacts, such as increased aggression, domestic violence, irritability, depression, suicide, excess use of alcohol or substance abuse to cope with stress (World Health Organization, 2017).

Prolonged exposure to extreme temperature events has also been reported to result in reduced employee productivity because people working under heat stress tend to slow down in their work rate and usually take more breaks to rehydrate and cool down in between the official hours (Mwasiaji & Alaro, 2022; Mayrhuber *et al*., 2018Park, 2016). Reduced productivity impacts negatively the overall economic performance of a given country (Buonocore *et al*. 2019). Rivulets of studies have also concluded that heat trapping greenhouse gas emissions and the attendant rise in temperature and sea level is expected to increasingly impact on companies and national economies that depend on natural resources and advantageous climatic conditions (IPCC, 2022; Sailor, Baniassadi, O'Lenick & Wilhelmi, 2019; World Health Organization, 2018; National Weather Service, 2017). With continued global warming, climate related events are expected to result in further degradation of livelihoods and related lasting consequences in many vulnerable communities in less developed countries, especially in the global south (IPCC, 2022; Lancet, 2020; Vaidyanathan, Malilay, Schramm, Saha, 2020; Taylor *et al*., 2018; WHO, 2018). Long term shift in weather pattern is therefore a global crisis that is being felt disproportionately around the world, with the

greatest challenge such as food and nutrition insecurity likely to affect more vulnerable communities and individuals especially in the Global South (IPCC, 2022; Mayrhuber *et al.*, 2018; Nangombe *et al.*, 2018). This is the basis upon which some proponents of Genetically Modified Organisms (GMOs) have put forth their proposal on the need for enhanced food crops and animal production systems through innovations in biotechnology, pointing out that the world's population will increase to about 10 billion by year 2050, thus increasing agricultural demand by roughly 50 percent compared to year 2013 (FAO, 2017). Genetically Modified (GM) food crops would therefore enable the realization of the set objectives of UN (2015) sustainable development goals (SDG) number two on zero hunger, with a cascading effect on others, such as those related to health and education (Lunghabo, 2016).

The Context of the Study

Kenya is located in Eastern part of Africa, with a population of about 48.5 million people, a land mass of 582,646Km^2 and a Gross Domestics Product worth USD 110.347 in year 2021, has one of the best diversified ecosystem in the world (FAO, 2021). These include mountainous, coastal, savannah grassland and dry land that is very conducive for nutritious crops such as maize, wheat, beans, tea, sorghum, millet, coffees, vegetables, onions and barley (World Bank, 2022; FAO, 2021; KNBS, 2019). Kenya's major industries in terms of their contribution to the country's gross domestic product (GDP) include tourism, forestry, fishing, manufacturing, mining, energy, financial services and agriculture which contributes about 50% of Kenya's foreign exchange and accounts for about 60% of the total employment in the country (World Bank Data, 2021; KNBS, 2019). Agriculture therefore remains the backbone of Kenya's economy and is therefore critical in food and nutrition security, employment creation and uplifting the living standards of the citizenry (KNBS, 2021; Makokha & Kyalo 2015). However, despite availability of arable land and seven counties, including Bomet, Nandi, Bungoma, Nakuru, Narok, Uasin Gishu and Trans Nzoia in Kenya producing surplus food, ten (10) others (Garissa, Isiolo, Wajir, Mandera, Mombasa, Marsabit, Nairobi, Turkana, Samburu, and Tana River) are not only food insecure, but are also in some cases experiencing conflicts over scarce resources (National Drought Management Authority, 2022; KNBS, 2021). This means that Kenya is facing daunting prospects in meeting the set objectives of Sustainable Development Goal 2 on zero hunger (FAO, 2022; UN, 2015). As a result, the cabinet in Kenya approved in September 2022 food crops produced through biotechnology innovations, as an intervention strategy for food and nutrition security within the parameters of climate change (Alliance for Science, 2022; BIBA Kenya, 2022). This approval attracted praise and protestations in equal measure, due to the ongoing debate by the stakeholders such as the academia, industry and regulatory agencies regarding the merits and demerits of GMOs (Arunrat, *et al*, 2017; Bagagnan, Ouedraogo, Fonta & Sowe, 2019; BIBA Kenya, 2022). This is the setting that formed the basis of the current study to provide a content analysis of extant literature consistent with genetically modified organisms as one of the strategies for climate change mitigation and adaptation measures in agribusiness sector for food security in Kenya.

Research Issue

Kenya is increasingly facing complex food and nutrition security challenges with an estimated 4.2 million people requiring food aid in the country (WFP, 2022; KNBS, 2021, FAO, 2021). This was part of the premise upon which the controversial cabinet approval was granted to allow for cultivation and importation of food crops produced through biotechnology innovations as an intervention strategy in the agribusiness sector (Alliance for Science, 2022). Unfortunately, Kenya wastes about 5.2 tonnes of food every year, amounting to about 58 million dollars, due to wasteful consumption that simultaneously exacerbates food insecurity (FAO, 2022; UNEP, 2021). This means that about 40% of food is lost from the farm to the fork (Were, Miricho & Maranga, 2019; Schneider, 2015), with every Kenyan wasting an average of 99 kilograms of food annually, as per UNEP's (2021) Food Waste Index Report and Waste and Resources Action Programme (2021). This wastefulness is also a contributor to the 8-10 percent of global greenhouse gas emissions, hence climate change, waste management challenges, nature and biodiversity loss associated with food that is not consumed (UNEP, 2021; WFP, 2022; FAO, 2022; Dou & Toth, 2020; Abeliotis, *et al*, 2015; Parry, Beazard & Okawa, 2015). Further, rivulets of research on GMOs have reported conflicting results on nutritional value, long-term effect on human health, ownership of technology, crosspollination of genetically modified (GM) with indigenous crops, and the issue of seed sovereignty (AFSA, 2019; Resnik. 2015; Delaney, 2015; Gilles-Eric S. et al 2014). In addition, the reviewed literature related to GMOs has mainly pursued discussions on the constructs of climate change distinctly from that of agripreneurship competencies and government regulatory framework in Agribusiness sector (Cao, 2018; Yang & Jin, 2019; FAO, 2017; Delaney, 2015; Resnik, 2015; Carrington, 2014; Oliver, 2014; Harmon & Pollack. 2012), in spite of the inferred indication that the three factors can be integrated and have an impact on food and nutrition security in Kenya (Mwasiaji & Alaro, 2022). Hence the need for studies to contribute to the ongoing debate on GMOs as an intervention measure towards the realization of objectives of the sustainable development goal number 2 on zero hunger in the world (FAO, 2022; UN, 2015).

Study Objectives

The study sought to critically evaluate genetically modified crops as an intervention strategy in agribusiness sector, agripreneurship competencies, regulatory framework and their impact on food and nutrition security in Kenya within the context of climate change.

The following specific objectives were formulated to guide the study:

(i) To examine GMOs as an intervention strategy for food and nutrition security in Kenya within the context of climate change.
(ii) To assess agripreneurship competencies in agribusiness sector for food and nutrition security in Kenya within the context of climate change.

(iii) To establish the level of food waste in Kenya within the context of climate change.
(iv) To evaluate the regulatory framework for GMOs in Kenya within the context of climate change.
(v) To identify gaps in Kenya's food systems within the context of climate change.
(vi) To give recommendations for addressing food and nutrition insecurity in Kenya within the context of climate change.

The research questions for this study were as follows:

(i) Are GMOs a viable intervention strategy for food and nutrition security in Kenya within the context of climate change?
(ii) What is the adequacy of agripreneurship competencies in agribusiness sector for food and nutrition security in Kenya within the context of climate change?
(iii) What is the level of food waste in Kenya within the context of climate change?
(iv) What is the regulatory framework for GMOs in Kenya within the context of climate change?
(vii) What are the gaps in Kenya's food systems thin the context of climate change?
(viii) What are some recommendations for addressing food and nutrition insecurity in Kenya within the context of climate change?

STUDY METHODOLOGY

This study reviewed relevant literature on GMOs and food security in Kenya within the context of climate change. The study used a meta-analysis approach in the collection and critical review of data from previous research findings, based on data generated from primary sources (Stovold, Beecher, Foxlee & Noel-Storr, 2014). The purpose was to identify data gaps with a view to formulating research propositions in an integrated theoretical model.

Review of Theoretical and Empirical Literature

The study examined theories and previous studies on long term shift in weather pattern and its link to human health, as well as literature on GMOs as an intervention measure in the agribusiness sector for food and nutrition security in Kenya.

Theories anchoring the Study

Various theories have been applied in seeking to understand and explain climate change interventions and their implications in the agribusiness sector in responses to long-term shifts in weather pattern (Bagagnan, Ouedraogo, Fonta & Sowe, 2019; Arunrat, *et al*, 2017). For instance the change theory which is a proposal geared towards explaining how a given adaptation on mitigation measure, or set of interventions, are expected to result in the specified positive outcomes, drawing on a causal analysis based on available empirical

evidence (Mwasiaji & Alaro, 2022; Stein & Valters, 2012). The change theory was judged to be useful for this study because adaptation and mitigation measures of climate change in Kenya are intended to achieve better outcomes for food and nutrition security in line with sustainable development goal number 2 (UN, 2015). The change theory in the context of climate change and building resilience supports the need for intervention measures to be guided by sound analyses, consultation with key stakeholders and learning on what works and what does not in diverse contexts drawn from best practices around the world (FAO, 2022; WFP, 2022; United Nations, 2017; IPPC, 2014). The theory of change further suggests that there is need to formulate practical solutions that can be deployed to effectively address the gaps that hinder progress and guide decisions on which approach should be taken during operationalization of adaptation and mitigation interventions for food and nutrition security in Kenya.

The other relevant theory is Planned Behaviour (Valois, et al. 2020; Ajzen, 1991) that have previously was applied in some studies that sought to identify climate change adaptation interventions for enhanced food security in agriculture related production (Valois *et al.,* 2020; Zhang *et al.,* 2020). Another theory is the Health Belief Model (Akompab *et al.,* 2013) or the Value Belief Norm (Zhang *et al.,* 2020) that have both been applied in previous similar studies. There is also the Protection Motivation Theory (Rogers, 1983), originating in health psychology and used extensively in risk research since the 1970s to assess individual's response to perceived threats of health problems and motivation to respond to the threats (Murtagh *et al.,* 2019). This study chose to apply the Protection Motivation Theory (Rogers, 1983) because it has been successfully applied widely in previous studies seeking to examine influences on preparedness for aspects of climate change, such as farmers' responses to drought (Dang, Li, Nuberg & Bruwer, 2014; Truelove, Carrico & Thabrew, 2015) and householders' responses to flood threat (Bubeck *et al.,* 2013). The application of the Protection Motivation Theory (Rogers, 1983) to this study was judged to be useful in assessing relevant variables impacting on climate change interventions in agribusiness sector for food and nutrition security in Kenya.

Debate on Genetically Modified Organisms

Biotechnology innovations for food and nutrition security in line with the global sustainability agenda (UN, 2015) have attracted much attention and hot debates amongst stakeholders around the world (Yang & Jin, 2019; Cao, 2018; FAO, 2017; Carrington, 2014; Harmon & Pollack, 2012; Doward, 2010). The ongoing discussion have been fueled by numerous studies on GMOs that have returned conflicting results, conclusions and recommendations on aspects such as ethical considerations, nutritional value, long-term effect on human health, ownership of technology, seed sovereignty, crosspollination and adequacy of local capacity to test for food safety to assure adherence to quality standards (National Biosafety Authority of Kenya, 2022; WFP, 2022; FAO, 2022; Dou & Toth, 2020; Walshe, 2019; Karembu *et al,.* 2017; Abeliotis, *et al,* 2015; Parry, Beazard & Okawa, 2015). Makokha and Kyalo (2015) for instance,

raised ethical objections and pointed out that the argument by proponents of GM crops to the effect that no study has conclusively proved that foods produced through biotechnology innovations have harmed humans beings does not in itself mean that the opposite is true because inadequate empirical evidence is not sufficient reason to conclude that they are not harmful now or in the future. In any case, some reports have emphasised the possible health risks on humans and livestock, along with its negative effects on the whole ecosystem (BIBA Kenya, 2022), while others view genetically modified organisms as a solution to fighting global hunger (Cao, 2018; Delaney, 2015). Those in support of safe biotechnology innovations point out that the world population will increase to about ten billion by year 2050, thus heightening agricultural demand by approximately 50% compared to year 2013, thus the need for new strategies to meet the demand (FAO, 2017; United Nations, 2017), such as improvement in the genetics of major crops and animal production system (Oliver, 2014). In line with the augment for innovations to enhance food productivity, Resnik (2015) argues that genetically modified food crops are not only safe for human consumption, but has also dealt with challenges including reduced and or loss in yield, competition with weeds for resources required to sustain growth and insect infestation. However, FAO (2017) advised that there is need to assess benefits and risks of genetically modified crops on a case by case basis.

In Kenya, Mbugua-Gitonga, Mwaura, Thenya and Pastorino (2016) reported that those against propagation of genetically modified crops have expressed concern over potential risks to human health, despite lack of such evidence in leading biotechnology countries. Due to growing population and continued land degradation as a result of poor farming methods, cutting down of tress, over use of grazing lands and climate change, countries in Africa including Kenya, must quickly come up with new ways to make farming more productive and profitable with agribusiness sector providing the greatest opportunities for job creation and improvement of peoples' standards of living (Moody & Chatterjee, 2018; Cao, 2018; DeRosier *et al*, 2015; Oliver, 2014). In addition, Karembu and Nguthi (2017) points out that there are safeguards as a result of Kenya having enacted its Biosafety Act in 2009 to ensure that Kenya takes advantage of the benefits of biotechnology innovations while at the same time protecting against probable risks. The proponents of GMOs further argues that realization of sustainable development goal 2 on zero hunger requires urgent intervention considering effects of COVID-19 pandemic and disruptions to agricultural supply chains and food exports caused by the conflict between the Russian Federation and Ukraine (Biosafety Authority of Kenya, 2022; WFP, 2022; FAO, 2022). On the other hand, those against approval of cultivation and importation of GMOs in Kenya argue that crops produced through biotechnology innovations are not only a threat to small scale farmers, but that they occupy large area of farm land and are linked to intensive monoculture systems that tend to do away with other crops and ecosystems, hence not in harmony with nature (BIBA Kenya, 2022; AFSA, 2019; Gilles-Eric S. *et al* 2014). In addition, the Biodiversity and Biosafety Association of Kenya (BIBA Kenya) opposes the approval of GMOs in the country due to lack of public participation as stipulated in Article one of the constitution of Kenya 2010, lack of regulatory capacity by the National Biosafety Authority to address safety concerns

and assure consumer preferences while at the same time mitigate against negative socio-economic impacts of GMOs in Kenya and the region (BIBA Kenya, 2022).

Gaps in Food Systems

Ensuring access to safe and nutritious food so as to enable all people to be nourished and healthy, depends not only producing in harmony with nature, but also the performance of food systems (FAO, 2022; WHO, 2015). The term "food system" is used here to refer to the collection of all activities along the value chain that are involved in the production, processing, storage, distribution and consuming food (FAO, 2021; UNDP, 2022). Studies have reported that the quality and performance of food systems profoundly affects the health of the people, planet as well as the health of economies and cultures (WHO, 2015; IPPC, 2022; FAO, 2022; WFP, 2022). Inefficiencies in the global food systems for instance result in food loss and waste, thus worsening the situation of the 50 plus million people in 45 different countries, who are experiencing acute food insecurity and thus teetering on the edge of famine (FAO, 2022; WFP, 2022). The food and nutrition insecurity situation has been worsened by effects of COVID-19 pandemic and supply chain disruptions brought about by the conflict between the Russian Federation and Ukraine (WFP, 2022). According to FAO (2022), the Russian Federation and Ukraine supplied about 30% and 20% of wheat and maize exports, making the two countries some of the most important producers of agricultural commodities globally. Russia and Ukraine also supply about 80% of sunflower seed products in the whole world (FAO, 2022; WFP, 2022). In addition, many low income food deficient countries not only do they heavily rely on Russia and Ukraine for their food supplies to meet their consumption shortfalls, but also fertilizers from Russia (FAO, 2022; WFP, 2022; World Bank, 2022).

On the other hand, the global economy losses about $940 billion due to post harvest food waste and losses, representing one third of the total agricultural production, further exacerbating food and nutrition insecurity, considering that as many as 828 million people often go to sleep hungry every night (UNEP, 2021; WFP, 2022). Food waste is used to refer to any food that is incinerated, discarded or otherwise disposed-off along the food supply value chain as a result of decisions and actions by food producers, suppliers, distributors, retailers and consumers (UNEP, 2022; Schneider, 2015; Wolf, 2014; Berman, 2014). Food is wasted in many ways such as during sorting operations as a result of failure to meet optimal parameters including shape, size and color; or foods that are close to, or beyond the "best-before" consumption date, or unused wholesome edible food or left overs that get discarded from household kitchens and eating establishments (FAO, 2022; UNEP, 2021; Were, Miricho & Maranga, 2019). According to UNEP (2021), 40% of the food that reaches consumers globally is thrown away, in addition to the 30% of the harvested crops going to waste in sub-Saharan Africa, impacting negatively to not only to the environment, but also on the income levels especially for small scale farmers. According to Tuppen (2014), about 45% of food waste and losses occurs along the value chain especially during preparation and cooking processes in household kitchens, 21% as a result of spoilage as a result of poor storage and

34% due to food wastes by customers as plate debris. Interestingly, the amount of food wasted annually along the agricultural supply and distribution value chain could feed about 1.6 billion people as compared to the 828 million people who are going hungry worldwide (FAO, 2022; UNEP, 2021). In Kenya, about 4.2 million people are going hungry (FAO, 2022), yet the country wastes about 5.2 metric tonnes of foodanually, amounting to Kenya shillings 72 billion (about 58 million dollars), with every Kenyan wasting on average 99 kilograms of food annually (UNEP, 2021; Waste and Resources Action Programme, 2021). This means that about 40% of food is lost from the farm to the fork (FAO, 2022; UNEP, 2021). Rotting food not only creates methane that has twenty one (21) times more global warming potential as compared to carbon dioxide, but also amounts to wasted resources including water, time, transportation and cooking energy (Restaurant food waste action guide, 2018). This means that managing food waste helps in stopping loss of money and the opportunity cost of wasted resources (Were, Miricho & Maranga, 2019; Schneider, 2015; Berman, 2014; Tuppen, 2014). This is the reason why the 2030 sustainability agenda target 12.3 proposes halving per capita global food waste at retail and consumer levels as well as reducing food wastages during production and distribution (UN, 2015; IPPC, 2022; FAO, 2022; WFP, 2022).

Some studies have also suggested that solution to food insecurity in Kenya requires sorting out structural issues such as existing gaps in the food ecosystem that contribute to poor productivity, food loss and wastage in the country (AFSA, 2019; Were, Miricho & Maranga, 2019). For instance, structural issues such as lack of planting coordination, and failure by farmers to follow planting guidelines resulting in produce flooding the market and or high rejection rate of produce due to food safety concerns (Walshe, 2019; AFSA, 2019). Other studies have pointed out the need to mitigate against value chain management constraints in the Agribusiness sector in Kenya, including high production costs, poor infrastructure, unsupportive government policies governing food system supply chains, inadequate agripreneurship competencies, lack of cold-chain and other required storage facilities at production level leading to huge post-harvest losses (Arunrat *et al*, 2017; Lunghabo, 2016; Mukembo & Edwards, 2015; Makokha & Kyalo, 2015; International Youth Foundation, 2014; Wolf, 2014).

Some of the required agripreneurship skills along the food value chain so as to start and optimally operate agribusiness enterprises include especially by the youth include Management Skills to manage human and non-human resources, such as time, finances and members of staff to facilitate achievement set goals (International Youth Foundation, 2014); Problem Solving Skills to enable planning and proper decision making by those managing agri-enterprises (Lunghabo, 2016; Mukembo & Edwards, 2015), Financial Skills to enable accurate forecast of cash flow and monitoring of the profits and losses (Paladan, 2015; International Youth Foundation, 2014), and Customer Relationship Skills to enable effective service delivery and promotion of agricultural products in the market (Uscanga, Edwards & Watters, 2019). Agripreneurship skill training may therefore be important in enabling performance of agrienterprises that are potentially not only in a position to provide

employment to millions of people along the value chain the agribusiness sector, but also the indirect economic opportunities as a result of the chain reaction (Mwasiaji, 2020; Mukembo & Edwards, 2015; Paladan, 2015).

Key Findings and Their Implications

This study established that Agriculture is a critical pillar of Kenya's economy and is critical for food security, employment creation and uplifting living standards of people in Kenya (FAO, 2022; KNBS, 2021; Walshe, 2019; AFSA, 2019). The study also revealed that wasteful food consumption (UNEP, 2021; Were, Miricho & Maranga, 2019; Restaurant food waste action guide, 2018), effects of climate change (Lancet, 2020; IPCC, 2019) and disruptions in food systems as a result of COVID-19 and conflict between Russia and Ukraine complicates Kenya's long-term goal of attaining nutrition and food security (FAO, 2022; WFP, 2022; Alliance for Science, 2022; National Biosafety Authority of Kenya, 2022). Further, rivulets of research on genetically modified organisms have returned conflicting results on enhanced food productivity, nutritional value, long-term effect on human health, ownership of technology, crosspollination, seed sovereignty and adequacy of capacity to test for quality standards (BIBA Kenya, 2022; Alliance for Science, 2022; Yang & Jin, 2019; Cao, 2018; Karembu *et al*,. 2017; FAO, 2017; Delaney, 2015; Resnik, 2015; Carrington, 2014; Oliver, 2014; Harmon & Pollack. 2012; Doward, 2010). This paper therefore argues that even though about four million people face hunger in Kenya, there is inadequate data and lack of consensus on cost benefit analysis of allowing open cultivation and importation of genetically modified food crops and livestock in the country. Vulnerable communities being ravaged by hunger in Kenya is due to gaps in the food value chains within the agribusiness sector, and wasteful consumption, rather than lack of food in the country. This implies that the premise upon which GMOs were approved in Kenya is faulty and exposes the country to the risk of losing seed sovereignty because the genetically modified seed market is dominated and controlled by foreign players. Approval and propagation of such seeds is also likely to expose especially small scale subsistence farmers to intellectual property laws by multinational corporations fronting genetically modified seeds which are protected under intellectual property rights. In any case, reducing waste in the food systems would result in sustainable consumption and more efficient land use with positive impacts on climate change and peoples' livelihoods. The debate about food and nutrition security in Kenya should therefore focus on enhancing the performance of the whole value chain from seed, production, postharvest and distribution factors. This requires the national and county governments in Kenya to put more emphasis on formulating long-term interventions in enhancing farmers' access to irrigation facilities, supported by adequate capacity building through agricultural extension services so as to equip farmers with knowledge on better agronomic practices. In any case, there is large agricultural land in Arid and Semi-Arid areas that remain under-utilized due to over-reliance on rain fed agriculture as opposed to supplementation through irrigation. The supposedly increased agricultural productivity through biotechnology innovations would not solve the food and nutrition insecurity in

Kenya without proper infrastructure to facilitate efficient and effective movement of food from one location in the country to another, along the value chain.

Integrated Model and Study Propositions

Propositions are valuable in seeking to explain, predict and understand a phenomena that may result in extending knowledge horizons within the scope of critical proposition (Mwasiaji, Mambo, Mse & Okumu, 2021; Bagagnan, Ouedraogo, Fonta & Sowe, 2019; Arunrat, *et al*, 2017). Based on review of literature related to food and nutrition security within the context of climate change, agripreneurship competencies and regulatory framework, this study identified data gaps on the best approach to fight against hunger. For instance, studies on climate change and food security have pursued the construct of genetically modified crops distinctly from that of agripreneurship competencies and legal framework in agribusiness sector (Alliance for Science, 2022; FAO, 2022; WFP, 2022; AFSA, 2019; Bagagnan, et al. 2019; Yang & Jin, 2019; Cao, 2018; Arunrat, et al. 2017; Mukembo & Edwards, 2015). There is need for studies to generate data based solutions on climate change intervention strategies in specific areas within the agribusiness sector, such as Crops and cropping systems; Agriculture support services; Processing and value addition; Marketing and sales; heat stress adaptation and mitigation measures in selected food deficient counties in Kenya. This study therefore has put forward three propositions at the abstraction level that can be integrated in a theoretical model to be advanced and empirically tested to generate data. Figure 1 presents the proposed integrated model including research propositions for further study using a combination of quantitative and qualitative methods to facilitate knowledge progression and enable the sealing of the recognized data gaps on food security in Kenya.

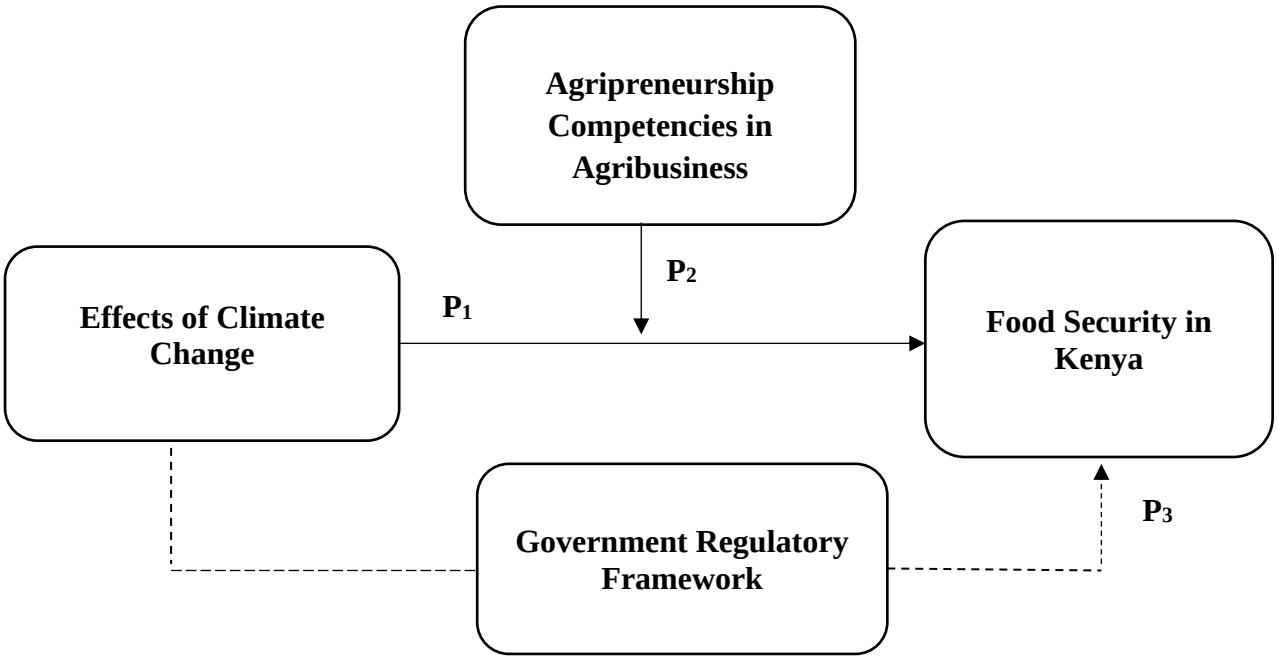

Figure 1: *An integrated model on Climate Change, Government Regulatory Framework, Agripreneurship Competencies in Agribusiness Sector for Food Security in Kenya.*

PROPOSITIONS

Climate Change and Food Security

Several studies have reported on the link between climate change, national economic development, food security, human health, agricultural and livestock productivity (IPCC, 2022; FAO, 2022; WFP, 2022; Lancet, 2020). Therefore taking urgent mitigation and adaptation measures against climate change, is critical considering the economic and social consequences such ill health, reduced labour productivity and lost man hours and hospitalization costs continues to place on nations' healthcare systems, including opportunity costs incurred by governments, the afflicted individuals and family members (WHO, 2022; Ute, 2018; Rohat, Flacke, Dosio, Dao, van Maarseveen, 2019). With regard to food and nutrition security, there is need for more studies on climate adaptation intervention measures to inform policy direction to guide planning and operationalization of smart agribusiness (IPCC, 2022; WHP, 2022; FAO, 2022; AFSA, 2019; Bagagnan, Ouedraogo, Fonta & Sowe, 2019). Thus, the study proposes that:

Proposition 1 ***(P1)****: There is a relationship between effects of climate change and food security in Kenya.*

Agripreneurship Competencies

Agripreneurship is taken here to refer to the application of entrepreneurial principles to identify, develop, and manage viable agricultural enterprise and projects optimally for profit and improved livelihoods (Mukembo, 2017; International Youth Foundation, 2014). Agripreneurship skill training may therefore be important in acquisition of agripreneurship competencies associated with entrepreneurship (Uscanga, Edwards & Watters, 2019). These include competencies such as opportunity recognition, creativity, flexibility, goal setting, high internal locus of control, leadership, endurance, awareness of target market, persistence, risk-taking propensity, social networks and being visionary (Krieger, *et. al.*, 2018: Mukembo & Edwards, 2015; Paladan, 2015; International Youth Foundation, 2014). Thus, the study proposes that:

Proposition 2 (*P2*): *Agripreneurship competencies have a mediating effect on the relationship between effects of climate change and food security in Kenya.*

Government Regulatory Framework

Government regulatory framework is used here to refer to the environment within which an enterprise operates and which can have a direct or indirect effect on its operations (Munjeyi, 2017). With respect to climate action in line with SDG 13, the Paris agreement was introduced in year 2015 to manage environmental degradation and limit global temperature increase below the pre-industrial levels (IPCC, 2022; Gao *et al.*, 2018). In Kenya, the Bill of

Rights in the 4th Chapter of the supreme law of the land, provides that citizens have the right to be free from hunger, and to have adequate food of acceptable quality (Constitution of Kenya, 2010). The fifth Chapter of the Kenya Constitution 2010 on Land and Environment lays an emphasis on the need to manage existing land resources efficiently, productively and sustainably while protecting and conserving ecologically sensitive areas. Thus, the study proposes that:

Proposition 3 (*P3*): *Government Regulatory Framework moderates the relationship between effects of climate change and food security in Kenya.*

CONCLUSION AND RECOMMENDATIONS

The purpose of this study was to review relevant literature and identify gaps in the phenomenon of GMOs, agripreneurship competencies, government regulatory framework in the agribusiness sector for food insecurity in Kenya. The study established that climate change has negative social and economic outcomes. This study concludes that there is inadequate data on cost benefit analysis of allowing cultivation and importation of genetically modified food crops in Kenya. Vulnerable communities experiencing food insecurity is due to gaps in food systems, rather than lack of food in Kenya. The study therefore recommends that discussions about food and nutrition insecurity in Kenya should focus on how to formulate supportive legal framework and improve agripreneurship competencies along the whole value chain from seed, production, postharvest and distribution factors. There is also need to shift and embrace irrigation as opposed to overreliance on rain-fed agriculture, while at the same time putting in place agribusiness infrastructure including efficient transport systems, Information Communication Technology (ICT) connectivity, cold storage and processing facilities, affordable energy and water. The study has also suggested the need to use an integrated model and some propositions to be tested as hypotheses to generate data to facilitate evidence based solutions to enhance agribusiness sector productivity, food and nutrition security in Kenya. The expected study output is improved agricultural productivity for economic growth.

REFERENCES

Abeliotis, K., Lasaridi, K., Costarelli, V., & Chroni, C. (2015). The implications of food waste generation on climate change: The case of Greece. Sustainable Production and Consumption, 3, 8–14. https://doi. org/10.1016/j.spc.2015.06.006

AFSA (2019). Farmers inspiring farmers to save seeds in Kenya. Retrieved on 3rd October 2022. Available at: https://afsafrica.org/wp-content/uploads/2019/11/kenya-english.pdf

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Akompab DA, Bi P, Williams S, Grant J, Walker IA, Augoustinos M (2013). Heat waves and climate change: applying the health belief model to identify predictors of risk perception and adaptive behaviours in Adelaide, Australia. Int J Environ Res Public Health 10(6):2164–2184. https://doi.org/10.3390/ ijerph10062164

Alliance for Science (2022). Kenya Approves GMOs after ten years Ban. Retrieved on 23rd October 2022. Available at: https://allianceforscience.cornell.edu/blog/2022/10/

Arunrat N, Wang C, Pumijumnong N, Sereenonchai S, Cai W (2017). Farmers' intention and decision to adapt to climate change: a case study in the Yom and Nan basins, Phichit province of Thailand. J Clean Prod 143:672–685. https://doi.org/10.1016/j.jclepro.2016.12.058

Bagagnan, A. R., Ouedraogo, I., Fonta, W. M., & Sowe, M. (2019). Can Protection Motivation Theory Explain Farmers' Adaptation to Climate Change Decision Making in The Gambia. Climate, 7(13): 1–14. doi.org/10.3390/cli7010013.

Beckmann SK, Hiete M, Beck C (2021). Threshold temperatures for subjective heat stress in urban apartments—analyzing nocturnal bedroom temperatures during a heat wave in Germany. Clim Risk Manag 32:100286. https://doi.org/ 10.1016/j.crm.2021.100286

Berman, S. D. (2014). Hospitality Directions US: Our Updated Lodging Outlook. Retrieved from Price Water Coopers: http://www.pwc.com/en_US/us/asset-management/hospitalityleisure/ publications/assets/pwchospitalitydirections-lodging-outlook.pdf

BIBA Kenya (2022). Stop the Government of Kenya from lifting the Ban on GMOs. Retrieved on 23rd October 2022. Available at: https://bibakenya.org/pages/articles/

Buonocore, J. J., Hughes, E. J., Michanowicz, D. R., Heo, J., Allen, J. G., and Williams, A. (2019). Climate and health benefits of increasing renewable energy deployment in the United States. *Environ. Res. Lett.* 14:114010. doi: 10.1088/1748-9326/ab49bc

Campbell, S., Remenyi, T. A., White, C. J., and Johnston, F. H. (2018). Heatwave and health impact research: a global review. *Health Place* 53, 210–218. doi: 10.1016/j.healthplace.2018.08.017

Cao C (2018) GMO China: How Global Debates Transformed China's Agricultural Biotechnology Policy. New York: Columbia University Press

Carrington D (2014). David Cameron's science advisers call for expansion of GM crops. The Guardian, 14 March. Available at: https://www.theguardian. com/environment/2014/mar/14/scrap-dysfunctionalgm-regulations-uk-government-science-advisersfood (accessed 25 October 2022).

Chaudhuri A and Datta A. (2018). Genetically Modified (GM) Crops: A Potential Source to Combat Global Hunger and Malnutrition. Austin J Nutri Food Sci. 2018; 6(3): 1106.

Dou, Z., & Toth, J. D. (2020). Global primary data on consumer food waste: Rate and characteristics – A review. Resources, Conservation and Recycling, 105332. https://doi.org/10.1016/j. resconrec.2020.105332

Doward J (2010) GM food battle moves to fish as super-salmon nears US approval. The Guardian, 26 September. Available at: https://www.theguardian. com/environment/2010/sep/26/gm-food-battlesalmon (accessed 25 October 2022).

FAO. (2022). The State of Food Security and Nutrition in the World. Food and Agriculture Organization of the United Nations. https://www.fao.org/3/cc0639en/cc0639en.pdf

FAO (2017). Genetically modified crops: Safety, benefits, risks and global status. Food and Agriculture Organization of the United Nations. https://www.fao.org/policy-support/tools-and-publications/resources-details/en/c/1477336/ (accessed 25 October 2022).

Harmon A and Pollack A (2012) Battle brewing over labeling of genetically modified food. The New York Times, 24 May. Available at: https://www. nytimes.com/2012/05/25/science/dispute-overlabeling-of-genetically-modified-food.html (accessed 25October 2022).

Hitt, M.A. Arrege, J.L. and Holmes, R.M. Jr. (2020). Strategic Management Theory in a Post-pandemic and non-ergodic World. Journal of Management Studies. http://doi.org/10.1111/joms.12646

Intergovernmental Panel on Climate Change **(**2022). IPCC report on Global Warming of 1.5 ºC. https://www.ipcc.ch/sr15/ Accessed on 4 April 2022

Intergovernmental Panel on Climate Change (2019). IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. https://www.ipcc.ch/site/assets/uploads/2019/ 08/Fullreport-1.pdf, checked on 11/12/2019.

International Youth Foundation. (2014). Promoting agricultural entrepreneurship among rural youth. http://www.iyfnet.org/sites/default/files/library/GPYE_RuralEntrepreneurship.pdf

Karembu M., Nguthi F., Chege P and Kipkorir B. (2017). A Decade of Success in Agri-biotech Grassroots Outreach in Kenya. African Agricultural Technology Foundation and International Service for the Acquisition of Agri-biotech Applications, Nairobi Kenya.

Kenya National Bureau of Statistics (2022). Economic Survey Report. Retrieved on 25th October October 2022. Available at: https://www.knbs.or.ke/wp-content/uploads/2022/05/2022-Economic-Survey1.pdf

Lancet (2020). The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises. Available online at https://www.clinicalkey.com/service/content/pdf/watermarked/1-s2.0-S014067362032290X.pdf?locale=en_US&searchIndex

Lunghabo, J.W. (2016, January 6). How we can make farming gainful? Daily Monitor. http://www.monitor.co.ug/Magazines/Farming/How-we-can-make-farming-gainful/-/689860/3021952/-/dexrxlz/-/index.html (Accessed on 4th August 2022).

Makokha, K. & Kyalo, W (2015). Ethical Objections to Commercial Farming and Consumption of Genetically Modified Foods in Kenya. Thought and Practice: A Journal of the Philosophical Association of Kenya (PAK) New Series, Vol. 7 No. 1, June 2015, pp 51-76

Mayrhuber, E. A.-S., Dückers, M. L. A., Wallner, P., Arnberger, A., Allex, B., Wiesböck, L., et al. (2018). Vulnerability to heatwaves and implications for public health interventions – a scoping review. *Environ. Res.* 166, 42–54. doi: 10.1016/j.envres.2018.05.021

Mbugua-Gitonga, A. Mwaura, F. and Thenya T. (2016). Biotechnology and Food Security in Kenya -An Assessment of Public Concerns on Biosafety, Public Health and Religious Ethics. Journal of Advances in Biology & Biotechnology 9(3):1-13

Mukembo, S. C. (2017). Equipping youth with agripreneurship and other valuable life skills by linking secondary agricultural education to communities for improved livelihoods: A comparative analysis of project-based learning in Uganda (UMI No. 10608552). [Doctoral dissertation, Oklahoma State University]. ProQuest Dissertations and Theses database.

Mukembo, S. C., & Edwards, M. C. (2015). Project-based learning: Equipping youth with agripreneurship and other valuable life skills by linking secondary agricultural education to communities for improved livelihoods. InnovATE Project, Virginia Tech University. http://www.oired.vt.edu/innovate/wp content/uploads/2015/09/MukemboProjectBasedLearning-FINALdocx.pdf

Murtagh N, Gatersleben B, Fife-Schaw C (2019) Occupants' motivation to protect residential building stock from climate-related overheating: a study in southern England. J Clean Prod 226:186–194. https://doi.org/10.1016/ j.jclepro.2019.04.080

Mwasiaji, E. and Alaro, L.O. (2022). Heat Stress Acclimatization Interventions for Employee Productivity in ISO 14001certified Firms in Kenya in the Context of Climate Change. *International Journal of Economics, Business and Management Research*. ISSN 2456-7760, 6(8), 220-234. doi: 10.51505/ijebmr.2022.6816. URL: http://dx.doi.org/10.51505/ijebmr.2022.6816

Mwasiaji, E., Mambo, S., Mse, G.S. & Okumu, J., (2021). "Conceptualizing Non-cognitive Attributes, Entrepreneurship Training, Pedagogical Competencies and Stem Education Outcome: An Integrated Model and Research Proposition*". International Journal of Technology and Design Education*. 31 (2) 1-15. DOI 10.1007/s10798-021. Available online. http://dx.doi.org/10.1007/s10798-021-09671-9

Mwasiaji, E. (2020). Sustainability Reporting in the Context of Small and Medium Business Enterprises in Kenya: A Conceptual Framework. International Journal of Business Marketing and Management. Volume 5 (1) January 2020, PP. 13-22 ISSN: 2456-4559

Nangombe, S.; Zhou, T.; Zhang, W.; Wu, B.; Hu, S.; Zou, L.; Li, D. (2018). Record-breaking climate extremes in Africa under stabilized 1.5 °C and 2 °C global warming scenarios. *Nat. Clim. Chang.* 2018, *8*, 375–380

National Biosafety Authority of Kenya (2022): Kenya Approved |GMOs. Retrieved on 23rd October 2022. Available at: https://www.biosafetykenya.go.ke/

National Drought Management Authority (2022). Early Warning Bulletins. Retrieved on 30th October 2022. Available at: https://www.ndma.go.ke/

National Weather Service. (2017). Weather Fatalities. Available online at: http://www.nws.noaa.gov/om/hazstats.shtml.

Paladan, N. (2015). Business university student entrepreneurial competencies: Towards readiness for globalization. Advances in Economics and Business, 3(9), 390-397. https://doi.org/10.13189/aeb.2015.030905

Park, J. (2016). "Will we adapt? temperature shocks, labor productivity, and adaptation to climate change in the United States (1986-2012)," in *Harvard University Economics Department Working Paper* (Cambridge, MA: Harvard University), 47. Available online at: https://www.belfercenter.org/sites/default/files/files/publication/dp81_jpark_hpca.pdf

Parry, A., Beazard, P. & Okawa, K. 2015). Preventing Food Waste: Case Studies of Japan and the United Kingdom (OECD Food, Agriculture and Fisheries Papers No. 76; OECD Food, Agriculture and Fisheries Papers, Vol. 76). https://doi.org/10.1787/5js4w29cf0f7-en

Restaurant Food Waste Action Guide (2018). New York: Rethink Food Waste. Retreaved on12th October 2022. Available at: https://refed.org/downloads/Restaurant_Guide_Web.pdf

Resnik, D.B. (2017). Ethical Issues in Field Trials of Genetically Modified Mosquitoes and Public Health Ethics, The American Journal of Bioethics, 10.1080/15265161.2017.1353170, 17, 9, (24-26), (2017).

Rohat, G.; Flacke, J.; Dosio, A.; Dao, H.; van Maarseveen, M. (2019). Projections of human exposure to dangerous heat in African cities under multiple socio-economic and climate scenarios. *Earth Future* 2019, *7*, 528–546.

Sailor, D. J., Baniassadi, A., O'Lenick, C. R., and Wilhelmi, O. V. (2019). The growing threat of heat disasters. *Environ. Res. Lett.* 14:054006. doi: 10.1088/1748-9326/ab0bb9

Schneider, F. (2015). Review of food waste prevention on an international level. Proceedings of the ICE-Waste Resource Management. (pp. 187-203). ICE-Waste and Resource Management. https://doi.org/10.1680/warm.13.00016

Seralini G.E, Clair E, Mesnage R, Gress S, Defarge N, Malatesta M, et al (2014). Republished study: long-term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize. Environment Sciences Europe 2014; 14-31.

Stein, D and Valters, C (2012). Understanding Theory of Change in International Development, JSPR and the Asia Foundation.

Stovold, E., Beecher, D., Foxlee, R. & Noel-Storr, A. (2014): Study flow diagrams in Cochrane systematic review updates: an adapted PRISMA flow diagram. Systematic Reviews 2014 3:54.

Tuppen, H. (2014). Reducing and Managing Food Waste in Hotels. Retrieved July 22nd, 2018, from Green Hotel.: http://www.greenhotelier.org

UNEP (2021). Food Waste index report 2021. Retrieved on 3rd October 2022. Available at: https://www.unep.org/resources/report/unep-food-waste-index-report-2021

United Nations (2015). Transforming our world: The 2030 agenda for sustainable development. In Resolution Adopted by the General Assembly on 25 September 2015; RES/70/1; United Nations: New York, USA.

United Nations (2017). World population prospects: Key findings and advance tables. https://population.un.org/wpp/Publications/Files/WPP2017_KeyFindings.pdf

Uscanga, J. M., Edwards, M. C., & Watters, C. E. (2019). What did aspiring young entrepreneurs in Nicaragua recognize as agribusiness and ecotourism opportunities using photo voice as a data collection tool? Journal of International Agricultural and Extension Education, 26(2). 29-47. https://www.aiaee.org/index.php/vol-26-2-august-19/1754

Vaidyanathan, A.; Malilay, J.; Schramm, P.; Saha, S. (2020). Heat-Related Deaths—United States, 2004–2018. MMWR. Morb. Mortal. Wkly. Rep. 2020, 69, 729–734

Valois P, Talbot D, Bouchard D, Renaud J-S, Caron M, Canuel M, and Arrambourg, N. (2020). Using the theory of planned behavior to identify key beliefs underlying heat adaptation behaviors in elderly populations. Popul Environ 41(4):480—506. https://doi.org/10.1007/s11111-020-00347-5

Walshe, C.O. (2019). Globalisation and Seed Sovereignty in Sub-Saharan Africa- Kenya: A Hyper globalized Seed Law. Palgrave Macmillan Cham. https://doi.org/10.1007/978-3-030-12870-8

Waste and Resources Action Programme (2021). Retrieved on 4th August 2022. Available at https://www.developmentaid.org/organizations/view/204745/wrap-waste-and-resources-action-programme

Were, S. O., Miricho, M. N., & Maranga, V., N. (2019). Study of Food Security Through Food Waste And Loss Control Mechanism In Kenya. International Journal of Tourism & Hospitality Reviews eISSN: 2395-7654, Vol 5, No 1, 2018, pp 09-21 https://doi.org/10.18510/ijthr.2018.512

Wolf, J. (2014). The relationship between sustainable supply chain management, stakeholder pressure, and corporate sustainability performance. Journal of Bussiness management. , 56-72. https://doi.org/10.1007/s10551-012-1603-0

World Bank (2022). Kenya's Growth Expected to Slow in 2022 Due to Ongoing Drought, Ukraine Crisis. Retrieved on 23rd October 2022. Available at: https://www.worldbank.org/en/news/press-release/2022/06/07/kenya-s-growth-expected-to-slow-in-2022-due-to-ongoing-drought-ukraine-crisis

World Food Programme (2022). Kenya. Retrieved on 3rd October 2022. Available at: https://www.wfp.org/publications/2022

World Health Organization (2018). COP24 special report on health and climate change. 2018. Available online: https://apps.who.int/iris/ bitstream/handle/10665/276405/9789241514972-eng.pdf (accessed on 3rd October 2022).

Yang, J and Jin, J (2019). One issue, different stories: The construction of GMO issues on Chinese, American and British mainstream media portals. Cultures of Science 2019, 2(4): 255–275

Zhang L, Ruiz-Menjivar J, Luo B, Liang Z, Swisher ME (2020). Predicting climate change mitigation and adaptation behaviors in agricultural production: a comparison of the theory of planned behavior and the Value-Belief-Norm Theory. J Environ Psychol 68:101408. https://doi.org/10.1016/j.jenvp.2020.101408

Woien, H. & Lama, L. (1999) Market Commerce as Wildlife Protector? Commercial Initiatives in Community Conservation in Tanzania's Northern Range- lands: Pastoral Land Tenure Series No. *12th International Institute for Environment and Development*,