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CLIMATE CHANGE AND FOOD VALUE CHAINS: THE ROLE OF RESEARCH, POLICY AND SUSTAINABLE PRACTICE

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ABSTRACT
Climate change had a significant impact on the food value chain, necessitating a comprehensive approach that involved research, policy, and practice. Research played a crucial role in understanding the complex interactions between climate change and food systems. It identified innovative solutions and developed climate-resilient agricultural practices. Policy interventions were essential to address the challenges posed by climate change. These interventions promoted sustainable land management, reduced greenhouse gas emissions, and ensured food security. Moreover, practical implementation through agricultural practices that focused on climate-smart techniques, waste management, and technological innovations was vital for mitigating the adverse impacts of climate change on the global food system. This paper explored the interconnectedness between these challenges and the crucial role of research and practice in building a more resilient food system in the face of the climate change challenge. It showed that climate change disrupted agricultural production through rising temperatures, changing precipitation patterns, and extreme weather events, threatening food security and livelihoods. Research on techniques to improve soil health promoted sustainable food choices through targeted educational campaigns that promoted environmentally conscious consumerism. Practices like diversified planting, zero tillage farming, and water-efficient irrigation techniques would have contributed to the farmers building resilience against climate extremes and promoting long-term food safety.

Keywords – Climate Change, Food Value Chain, Research, Policy and Sustainability.

1.0 INTRODUCTION

Climate Change (CC) has been described as "long lasting shifts in weather patterns and temperatures" (United Nations 2022). According to the Nigerian Climate Policy (2010) it has been referred to as the "human induced modifications in weather patterns having local, national, regional and global impact likely to become severer over time. These impacts originate from Green-House-Gas (GHG) emissions causing "a global Green-house effect which in turn facilitates a "Green-house effect" creating global warming (increase in temperature) and loss in the earth's protective ozone layer. The culmination of these preliminary actions has been proven to cause rise in global ocean levels, depletion of polar ice shelves, flooding, desertification, loss of biodiversity as well as catastrophic storms. Based on current predictions, these catastrophes have been foreseen to magnify over the coming decades if sustainable changes are not made in curbing green-house gas emission. Empirically, research uncovered a 0.80C increase in global temperature and predicts that same could reach 20C by 2060 (PACJA, 2009). Should such be the case, catastrophic alteration in climatic conditions of communities, nations and regions could be adversely leading to food supply shocks, food shortages, famine, starvation and large-scale death.
In a bid to combat and abate a pending global catastrophe staring humanity headlong, several climatic frameworks such as the 2006 Kyoto protocol, Sustainable Development Goals (IFPRI

Report, 2024), the 2015 Paris Agreement, the 1993 UN framework Convention on Climatic Change (UNFCCC) and the 2023 UN Climate Change Conference – Conference of Parties (COP 28) are a few of the international frameworks established for action on CC adaptation, mitigation, and resilience (United Nations, 2022).

Worthy of note is the 2015 Paris Agreement which aimed at addressing the global crisis of Climate Change. Nearly every country of the world (197 countries) got together to develop the Accord. The 3 objectives of the Agreement are:

a) for countries to reduce their greenhouse gas emissions;
b) to stop average global temperatures from rising to 1.5 degrees Celsius by 2050;
c) and to help people and the planet better manage the effects of CC. Paradoxically, despite the signing of this Agreement by most nations of the world, little or tangible adjustments have been made in executing its aim (IFPRI Report, 2024).

2.0 THE CONCEPT OF FOOD VALUE CHAIN (FVC)

The FVC consists of all stakeholders participating in the coordinated production and value adding activities that are needed to make food products. According to FAO (2014), a Sustainable Food Value Chain Development (SFVCD) is one that is

a) profitable throughout all of its stages (economic sustainability).
b) It must have broad-based benefits for society (social sustainability)
c) and have a positive or neutral impact on the natural environment (environmental sustainability).

Here, the concept of the value added to the food chain, is the difference between the nonlabour cost of food production and the average consumer's ability to pay for it. This difference is then adjusted for the positive or negative externalities created during the course of production. Where a food processor pollutes a neighbouring river (negative externality), its action negatively affects the income of fishermen while its construction of a road (positive externality) benefits its host community. This concept is further illustrated in Figure 1.

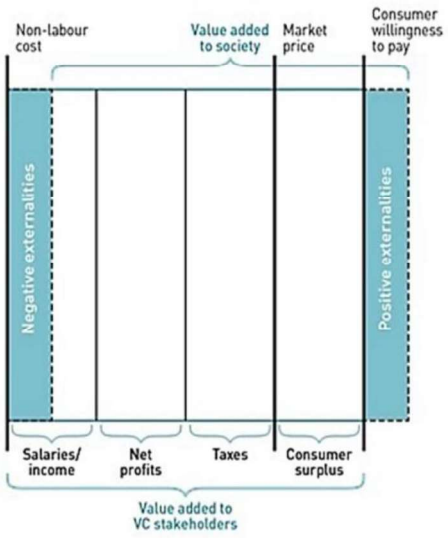

Figure 1: The Value-Added Concept in Food Value Chain (FVC) Development **Source:** FAO, 2014.

In tandem with Figure 1, a sustainable food value chain development transcends linking smallholder farmers to a particular value chain as four other added value types are created. These values include -job creation, creating salaries/incomes, increased profits, revenue to the government (taxes) and consumer benefits. These have promoted the wellbeing of rural dwellers as more people push to derive their livelihoods from jobs other than running farm businesses directly. Further development of food value chains ensure that healthier and cheaper food is delivered to markets in abundance creating a large developmental impact, even without additional farmers being in the chain, as everybody consumes food (FAO, 2014).

Sustainable Food Value Chain development (SFVC) identifies that, value chains are dynamically driven by market forces in which coordinated control is the focus. Also, added value and sustainability are explicit, multidimensional performance measures, assessed at the aggregate level. The concept also accentuates on a holistic "triple bottom line" approach in cognizance to the three main dimensions of sustainability economic, social and environmental as shown in the Figure 2.

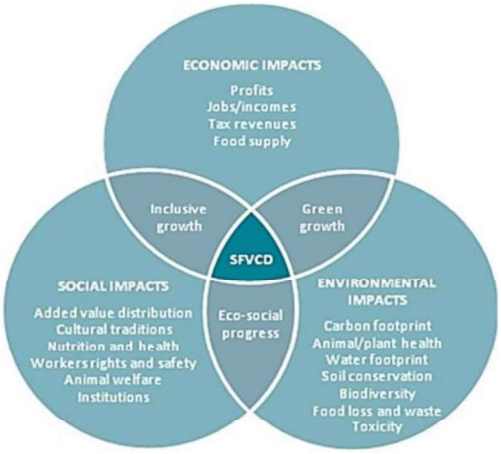

Figure 2: The Concept of Sustainability in Food Value Chain Development (SFVCD)
Source: FAO, 2014

Figure 2 illustrates the conceptual framework of the FVC, where SFVCD is considered as the fundamental component of a multifaceted system of:

a) economic impacts (profits, jobs/income, taxes and food supply),
b) social impacts (added value distribution, cultural traditions etc.)
c) and the natural environmental impacts (carbon foot print, soil conservation, water footprint biodiversity etc.) that control the behaviour and performance (inclusive growth, green growth and eco-social progress) of farms and other agribusinesses.

Within the SFVC framework, the core of FVC consists of 4 major actors operating within governmental control which in turn, is regulated by the economic factors of service provision, capital (finance) and availability of raw materials (input provision) within the wider extended value chain framework. The core FVC actors comprise –

a) the producers (farming, fishing, forest harvesting or agro-forestry),
b) the aggregators who buy off farm produce from numerous small farm holders creating bulk quantities for onward delivery to value adding processors. This is as illustrated in Figure 3.
c) The aggregation step is specifically vital to FVCs in developing countries where efficient collation, batching and storage of farm produce sourced from many small farm holders is usually a concern.
d) The value adding processors finally dispose same via the distributors (wholesale and retail) to the final consumers within the immediate and international markets.

In creating a holistic national enabling environment, the components of the extended value chain must integrate sustainably with

a) natural factors (environmental elements - freshwater sources, soils, biodiversity, climate etc.),
b) be acceptable to society (socio-cultural - religion, history, language, etc.,),
c) organization (schools, research and development facilities, national commodity associations, etc.),
d) institutional (policies, laws, customs and other socially embedded rules,
e) private sector-based rules such as voluntary standards, etc.)
f) and infrastructural elements (roads, markets, ICT, electricity grids, backbone public irrigation structures, etc.). Where this synergy is possible, a global enabling environment for FVCs is achievable.

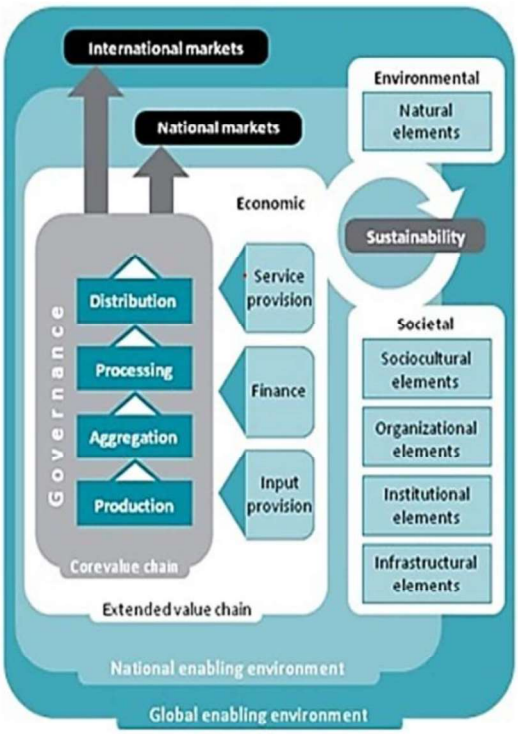

Figure 3: The Sustainable Food Value Chain (SFVC) framework
Source: FAO, 2014

3.0 IMPLICATIONS OF CLIMATE CHANGE FOR FOOD VALUE CHAINS (FVCS)

Climate Change is expected to impact on principal elements of the FVC as exemplified in Figure 4. These include the a) Production (farm inputs and on-site production), b) Aggregation (Trading, bulking, storage), c) Processing, and d) Distribution (Wholesale and retail) components of the core value chain.

Individual components are expected to be impacted and remodelled in three different patterns -:a gradual erosion of value; amplified food shocks and an increased propensity for civil conflicts. With on-site crop and animal production being obviously impacted by Climate Change, postharvest risks and losses would be amplified. Inevitably, this would alter the scope of financial inducements offered by agricultural finance and insurance providers. The creation of food shortages would threaten the livelihoods of both rural and urban dwellers as food insecurity spikes civil strife and conflict, which inevitably disrupts the whole value chain process.

The entire FVC maybe altered by a change in consumer preferences which may arise from a change in diet, demand for more sustainable value products etc. Where this occurs, the change impacts all actors in the value chain from the small farm holder to the largest consumers.

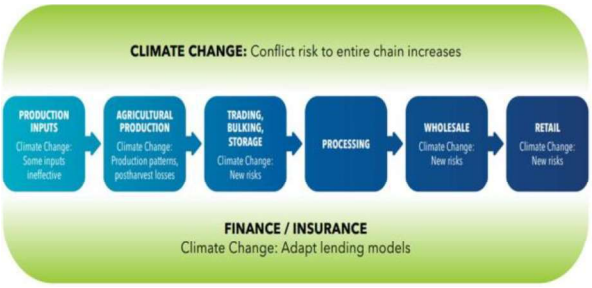

Figure 4: Potential Impact of CC on FVCs
Source: Brauw and Pacillo (N.D.)

3.1 Variability in Production Pattern

Changes in the pattern, frequency and volume of precipitation, temperatures, and humidity levels in developing and underdeveloped nations are projected to escalate stress on agricultural production systems. Consistent change in weather patterns will likely improve weed action, introduction and stimulation of the prevalence of new diseases, increase in pest populations and a potential reduction in the viability of farm inputs such as herbicides, pesticides and integrated pest management.

In addition, Climate Change increases the likelihood of increased exposure to extreme weather events creating a greater impact on food production in the nearest future. The accumulated impact of these bizarre occurrences would definitely reduce the potentials for maximized farm output thus affecting the economic viability of agricultural output. Reliant upon subsequent low farm yields, market conditions and transaction costs within the FVC, the production patterns of small farm holders would drastically change (Brauw and Pacillo, N.D.).

Consequently, the downstream value chains for farm produce either for domestic or international markets would need to adjust for adaption. For example, if it becomes too dry to grow cassava in Umuagwo - Imo state, farmers may have no other option than to opt for the cultivation of maize, peas, millet and other suitable grains. This would translate to cassava traders having to adjust their purchases to buying grains and also, locate buyers for the stock of grains being produced in the stead of root crops.

3.2 Increased Food Waste and Loss in Nutritional Value

Currently, one-thirds of farm harvests are estimated to be lost globally (IPCC Report, 2022). This occurs within the individual components of aggregation (handling, sorting for storage, preservation, packaging etc), transportation, wastes generated at points of wholesale and retail (FAO, 2017). This being exclusive of wastes further generated by consumers due to power outages especially in developing and underdeveloped nations.

With Climate Change, the level of post-harvest losses would spike up further due to increase in temperature and humidity levels. With greater humidity, drying times for grains would be lengthened thus increasing its susceptibility to spoilage through contaminations, mold infestations and pest attack. Increased farm cost maybe recorded where energy other than solar energy (outdoor drying) needs to be procured to enhance drying times and appropriate technologies for storage other than conventional modes would be needed to combat spoilage (Brauw and Pacillo, N.D.; IPCC Report, 2022).

At higher temperatures, perishables such as fruits, vegetables, and animal-sourced foods, which have short shelf lives degenerate rapidly. The loss of these food types is of concern as these provide the

critical micronutrients necessary for healthy living which maybe glaringly absent in populations situated in developing and underdeveloped nations. Therefore, the impact of Climate Change in promoting the spoilage of short-shelved lived farm produce could make perishables and their associated micronutrients even scarcer. With increased scarcity of these foods, food borne pathogens like salmonella in animal-source products, will likely become more prevalent. Traditionally, certain perishables maybe cheaply dried or locally processed by boiling, roasting, salting etc. to abate spoilage but these techniques lead to nutrient loss (Brauw and Pacillo, N.D.).

3.3 Finance, Insurance, Input Provision and Service Provision

Providers of finance and insurance services for agricultural production can be predicted to repattern their lending and coverage behaviour in reaction to variations in perceived risks within the core FVC. Though, lenders and insurers may be able to adjust to growing risks by modifying terms of loans and insurance to investors in agriculture, cumulatively, locally sourced investment funds and insurance may dwindle.

In the same vein, associated service providing firms within the value chain may change their investment policies without notice causing huge impacts on agribusinesses. For example, if storage within the humid climates is negatively affected, maize becomes susceptible to mold when stored before it is dry, and with increased humidity, traders become more averse to storing maize. More so, financial instruments dependent on the agglomeration activities such as storage becomes, riskier thus possibly impacting farmers' access to finance negatively. Furthermore, in FVC, dependent on finance for inputs, such as grapes or cotton chains, reduced inputs would invariably reduce yields as well as aggregate harvests in regions (USDA, 2015). This would also create a cascading reduction in the returns to trading and processing the particular crops. This is envisaged to foster the exit of certain market actors in the value chain (Brauw and Pacillo, N.D.).

3.4 Smallholder farms and Vulnerable Populations

The brunt of Climate Change on FVCs are mostly borne by smallholders. This is envisaged as during farm crises; it is easier for governments to assist large farm holders than a conglomeration of hundreds of small farm holders. Rationally, small scale farmers maybe termed "high risked" by financial institutions unlike large farm holders and are rarely ever able to access credit or formal sources of insurance. This maybe predominantly true for female and minority value chain actors, who already have constrained access to finance.

Thus, it would be challenging and expensive to assist small scale farmers to adjust to steady variations in farm output. Where the government is willing to assist small scale farmers, reaching/locating them may be difficult due to the far-flung locations of their farm steads. More often, traditional farmers stick to old farming methods rigidly and maybe unwilling to change their farming practices due to superstitious beliefs (Brauw and Pacillo, N.D.).

3.5 Civil Strife and Conflict shocks

Where climate crisis ignites civil unrest and conflicts in urban areas, the tendency for increased negative impacts on existing FVC is heightened. Substantial evidence has proven that scarcity of natural resource as well as food insecurity ignites unrest and chaos especially in situations where negative climate impacts, associated with other vices such as insecurity, hunger, poverty, inequality exists. In other climes, reduced farm output coupled with natural resource scarcity caused by CC and variability could negatively impact food quantity and quality leading to increased food prices for less quality foods (USDA, 2015). Also, food and nutritional insecurities could heighten economic shock amongst the poor and vulnerable resulting in fragile economies characterized by civil unrest, protests, riots and risks of theft when transporting foods produce through improvished /conflict areas.

Where there is a large gap in-between the rich, middle class and the poor, social and political marginalization, existing vulnerabilities, climate-induced strains and conflicts may become frequent occurrences. These conflicts / induced risks do not only impact individual FVC components but may affect or severely damage whole FVC systems. Thus, there is the need for FVCs to be made adaptable to both Climate Change and conflicts induced shocks.

3.6 Nature of Consumer Demand

The nature of consumer demand may alter as a result of CC and variation as well-informed and financially capable consumers change their demand for more sustainably food options. Where large shifts in demand are created, prices of sustainable

food items may increase as sustained increase in demand by consumers, motivate producers and processors to change production in favour of more environmentally sustainable crops and technologies. Albeit, many problems could spring up (IPCC Report, 2022).

Initially, consumers may want proof or assurances that the purchased products of choice are actually sustainably produced. This in turn increases the possibility of product audit, traceability, quality control tracking as well as process standards (World Bank Report, 2023). Where consumer demand substantially increases for sustainably produced food products, certification and quality control bodies would need to be established to ensure products conform to the expected public and national standards.

Thereafter, increased demand for sustainable certified foods may eventually create increased inequality between food options as agri-preneurs who lack the necessary resources to meet newly set standards are worse off for it. Alternatively, where agri-preneurs expand the scope of production for certified products with a short period of time, it is likely that a portion of the certified food would be sold into uncertified markets at lower prices, thus de-motivating their participation.

4.0 ADAPTING FOOD VALUE CHAINS TO CC.

FVCs are clearly at the mercy of CC since it offers little or no form of assistance presently. Thus, agri-FVCs must be made adaptive to CC for sustained livelihoods. In 2019, the agricultural FVC was reported to have contributed 17% of total global GHG emissions globally (IPCC, 2022). By 2023, the same GHG contribution had risen to 34% but the FVCs were reported to account for 18-29% of the total GHG emissions (IFPRI Report, 2022; World Bank Report, 2023). To combat this emission, smallholders who constitute a huge chuck of the farming population in Nigeria and particularly women, must be assisted in adapting to Climate Change and its attendant impact on the value chains into which they sell their farm produce.

In practice, two possible solutions can be initiated both of which require government intervention. First, governments and other stakeholders can act to prevent climate-related food waste and loss that reduce food security and nutrition. This can be achieved by provision of social infrastructure such as roads linking the markets to the production centres and adequate storage technologies that can reduce both postharvest losses and Green House Gas emission, even if the reduction in emission cannot be effectively quantified (Ani and Anyika, 2021; World Bank Report, 2023).

Second, suggestions on better monitoring can be utilized to enable governments and the private sector identify hurdles along FVCs, adapt value chains to Climate Change and ensure stability and sustainable food security on the long run.

Furthermore, in ensuring that the whole food value chain is made climate friendly, each subset of the chain must be reviewed and made compliant to acceptable Climate Change regulatory standards. This can be achieved via research, policy making, sustainable farm practices amongst others. These are as discussed below:

4.1 (i) Research

Research plays a vital role in understanding the specific threats and developing solutions. It involves the intensification of agricultural research in agriculturally based universities and institutes, quasi-governmental organizations etc towards proffering technical solutions. Importantly, research output must go beyond paper publication into product development (eg. the development of drought resistant crop and animal species / varieties, capable of combating pests, diseases, heat stress) for the sustainability of food systems (USGCRP, 2014). Furthermore, climate friendly pesticides, herbicides, fertilizers and other farm additives must be researched into for production, commercialization and enforcement via policy to farmers for subscription. Research plays a crucial role in developing and implementing strategies for a more resilient food system (Haji &Himpel, 2024) and investments in research need to be expanded into the future, not least to ensure viable agricultural systems in the long term when climate change will expose current staple food crops to unprecedented stress. Areas for investment lies in developing climate-smart agriculture (CSA) practices. This encompasses a range of techniques that enhance agricultural productivity, adaptation capacity, and mitigation of greenhouse gas emissions (Zheng et al., 2024). Developing crop varieties tolerant to high temperatures, low water availability, and increased salinity (Budhlakoti et al., 2022; Muhammad et al., 2024). Gene editing techniques and marker-assisted selection hold promise for faster development of

these varieties. Innovative irrigation systems like drip irrigation and precision agriculture helps to improve water-use efficiency and reduce reliance on rainfall (Levidow et al., 2014). Additionally, soil health practices like cover cropping can enhance water retention capacity. Researchers are investigating methods to improve soil fertility, reduce reliance on chemical fertilizers, and promote biodiversity within agricultural systems (Krasilnikov et al., 2022). These practices can contribute to increased resilience against climate extremes and promote long-term sustainability.

(ii) Establishment of Secondary weather/meteorological stations in Agricultural Research Institutions within each State of the Federation

As an adaptive approach in addressing CC, establishment of sub weather stations within research institutions for synergized weather forecast output is crucial in addressing on-site food production (Ani and Anyika, 2021). As farmers don't have the means of predicting the change in weather patterns which affect planting seasons, precise and timely weather information can be relayed to the farmers' club/cooperative without communication hindrance. This also abates loss of farm income created by waste of farm input such as seeds, stem cuttings that maybe lost should the expected rains fail (Durán-Sandoval et al., 2023). Instruments such as rainfall sensors, wind speed transmitters, atmospheric humidity sensors etc measure weather components such as wind, humidity, sunshine intensity etc.

4.2 Climate Policy and Decision Making

Climate Policymakers have a crucial responsibility in creating a supportive framework for climate-resilient practices. In practice, numerous policy types geared at influencing Green House Gas emissions and combating Climate Change have been implemented. Notably, most of these policies fashioned, enacted and implemented in the western world, can be adapted to suit the African scenario. According to Gough (2011), some of these policy types include:

(i) Mitigation Policies: Governments must establish action demanding and legally binding commitment to reduce CO2 and other GHGs. The policies must have statutory targets and must be monitored by specialized agencies in order to advise government on setting and meeting carbon budgets. Eg. the UK Climate Change Act 2009 which is hailed as the world's most demanding.

(ii) Adaptive Policies: About ten years ago, two pilot projects were deployed to develop season-to-season prototype climate forecasts in West and Central Africa. It was established with the goal of synergizing active partnerships amongst users, academia, national meteorological and hydrological services as well as regional institutions. It is envisaged that the outcome of this project would enhance the adaptation of the food chain to the prevalent change in weather and climate conditions of the region for food security and nutrition. Furthermore, its results are geared at aiding future planning and policy formation in the sub-national, national and regional levels.

(iii) Economic Incentives: In Europe, the main driver of carbon reduction over time has been the EU Emissions Trading Scheme (ETS) which applies to large industrial concerns including power generation. It sets an overall cap and requires companies to submit allowances to cover their verified emissions (Ani and Anyika, 2021). It is expected that the ETS will deliver two-thirds of the first three UK carbon budgets. Another alternative to the ETS is carbon taxation. Different policy instruments can be used to achieve desired outcomes. Targeted subsidies can incentivize the adoption of climate-smart technologies or practices, though concerns exist around cost effectiveness and potential for inefficient resource allocation (Khatri-Chhetri et al., 2019). These can be adapted to the African setting and made viable in the provision of incentives towards the fight against Climate Change.

(iv) Outright Regulations: In much of the western world, the use of the traditional 'command-and-control' mode of regulation which prescribes a level of pollution diminution and the use of institutional measures, aimed at directly influencing the environmental performance of polluters has been effective. Numerous regulations covering energy performance of buildings, limits for car emissions, cooling refrigerants, switch to energy saving bulbs etc. have been enforced

and accepted knowingly or ignorantly by the populace.

(v) Education, Information Dissemination and Behavioural Change: Referred to as the components of "Action for Climate Empowerment" (ACE), this aspect of Climate Change policy can be further broken down into six segments: ln line with PIUA (2022), the six components of ACE have further been summarized to three as follows:

(a) Public Access to information, Education and Training: People should be made to have access to climate information so that the right knowledge required to take tackle Climate Change individually and collectively dissipated.

The ordinary citizen must become aware of climate health. This can be achieved via incorporating climate health issues into school curricular in a bid to ensure that the coming generations learn about and understand Climate Change, its causes as well as the possible strategies and actions to address it. This would set a sure path in abating further climate destruction.

The creation of Climate health clubs among our students and its likes, are needed to practically empower citizens in taking action that encourages sustainable ways of living without damaging the health of the planet using practical approaches.

(b) Public Awareness and Participation: The need to create public awareness in intimating the citizenry of the gravity of Climate Change and the need to tackle it through individual, collective, social, and political approach is necessary. This would ensure everyone or a larger percent of mankind is on the same page in the fight against Climate Change. By this means, better climate policies and actions can be executed leading to the necessary social change that support climate justice. Furthermore, everyone must have a voice (children, young people and adults) in the Climate Change decisions impact on them and their immediate environmental health.

(c) International Cooperation: Knowledge flow between countries of the world, on best practices in helping the fight against Climate Change cannot be overemphasized. The exchange of Climate Change experiences, knowledge and means of tackling same amongst countries increases the ability and resolution to fight the menace. Importantly, means by which finance is generated to fund climate actions can be communicated to each other for more tenacious Climate fight.

4.3 Components of Sustainable Practices

i. Use of Suitable Climate Technologies: With the use of modern weather technologies in primary and secondary meteorological centres, precise weather measurements (in-between seasons lasting 15-90 days) can provide accurate predictions on the start of rainy season and its end due to its irregularities in weather pattern. Armed with this precise information on the date and volume of rain expected, farmers are able to establish dates for sowing crops, or opt for fast-maturing alternatives, depending on how the duration of the planting season is affected (Ani and Anyika, 2021). Also, precise in-season and season to season weather measurements could also provide early warning of high-impact events such as wind and rain storms, floods, droughts, heat and cold waves, frost etc(CR4D, N.D; Durán-Sandoval et al. (2023). Utilizing sensors and data analytics to monitor soil moisture, nutrient levels, and crop health allows farmers to target interventions and resource optimization (Ogle et al., 2005).

Climate Adaption Measures must be promoted at the farm level for crop production activities such as: dry season planting, early planting, use of drought-tolerant seeds, crop diversification, mulching, water storage and natural barriers, among others (CGIAR, 2016). Practices like no-till farming, mulching, and cover cropping improves soil health, increase water retention capacity, and reduce erosion, making farms more adaptable to changing weather patterns (Angon et al., 2023; Neufeldt et al., 2013). Techniques like drip irrigation and precision agriculture allow for

targeted water application, minimizing water waste and maximizing efficiency, particularly in drought-prone regions (Haruna et al., 2023; Ingrao et al., 2023).

ii. Crop diversification: multi-cropping
iii. Agro forestry: The promotion of integrating trees crops into farming practices
iv. Soil and water management conservation: Promotion of reduced soil tillage and increased water harvesting abilities in order to improve soil health, water use efficiency and soil restoration while reducing erosion.
v. Integrated pest management: This involves the use of series of pest management strategies such as crop rotation, biological control, use of resistant varieties to reduce outbreaks and reliance on synthetic pesticides (Ani and Anyika, 2021).
vi. Consumers play a vital role by making informed choices and reducing food waste. Especially in raising awareness about the environmental impact of food choices and promoting sustainable consumption practices through educational campaigns (Kassie et al., 2015). Supporting local and sustainable food producers by prioritizing locally grown produce and products from farms known for sustainable practices. Reduction of food waste at home through proper storage, meal planning, and creative utilization of leftovers. This can significantly reduce the environmental footprint of food consumption (Haruna et al., 2023)

5.0 CONCLUSION

In the face of Climate Change and survival, investment into climate science and research, in modifying FVCs to suit current realities is imperative. Research into the use of sustainable practices such as varied cropping patterns as well as the use of technologies in predicting seasonal changes in weather conditions must be executed and results established. This is a fundamental step as Climate Change cannot be fought with guess work and unreliable data. The drive to mitigate and reverse the negative impact of Climate Change must be taken seriously by Governments of the world to ensure sustainable food security in the face of increased threat to food and nutrition insecurity. Such interventions would ensure that FVCs are suited to combat Climate Change concerns and not to induce it. Climate Change Policies made in the immediate and short term must be centred on the reduction / elimination of food loss via value chain waste in order to increase FVC efficiency while reducing the local environmental pressure attendant with food system development. Thereafter, policies for medium term should focus on investment in technological infrastructure powered by climate friendly/smart energies. The development of green energy and the need to enforce its use as against the use of fossil fuel could be encouraged and promoted. Public infrastructure such as the creation of sustainable roads linking production sites to markets and the development of cold room chains would assist in assuring food security.

Finally, government investment and policies centred on battling Climate Change must not only be made and enacted, same must be monitored and appraised overtime for effectiveness as this would further ensure that the possibility of civil unrest and its likes, emanating from the impact of Climate Change is nipped at the bud. In addition to stemming civil disorder, monitoring of policy effectiveness as well as investment would go a long way in ensuring that small farm holders and other vulnerable actors in the FVC are well adapted in the new climate variation while protecting and improving food supply.

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