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Original Article

Investing in Agriculture for Long-Term Food, Income, and Nutrition Security: An Economic Analysis of Crop Production and Marketing in the Refugee and Hosting Community Settings in Turkana

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Abstract: *The research study was conducted throughout the entirety of Turkana to evaluate the performance of the agriculture sub-sector, considering its scope, challenges, and opportunities. Three study objectives were formulated to direct the exploration of various aspects of the research topic, i.e., (i) to assess the state of food, income, and nutrition security in Turkana; (ii) to explore the enablers and inhibitors of field, horticultural, and cash crops in Turkana; and (iii) to identify strategies to increase agricultural performance and address the inherent production and marketing challenges. The study's research design was exploratory, involving in-depth collection, analysis, and presentation of data through descriptive and qualitative techniques. The study engaged 40 resource persons holding expertise in agriculture, natural resources management, refugee livelihoods, agribusiness, community development, social protection, and policy. Respondents are working for national and county governments, UN agencies, NGOs, corporations, research institutions, and community-based organizations, including refugee-led organizations (RLOs) and farmers' field schools. All were selected purposefully. Households focusing on either field, horticultural, and/or cash crops were categorized, forming strata from which study participants were randomly selected. A total sample of 126 people (48% female) were selected, and study questionnaires were administered. The study revealed a significant potential for agriculture in Turkana, where different crop categories can flourish with the implementation of appropriate strategies and investments. Despite this potential, Turkana faces numerous challenges that can hinder agricultural performance and marketing, thereby perpetuating the current food, income, and nutrition insecurity in the region. The study emphasizes agriculture's role in bridging the widening gap in food security in Turkana and for the refugee population due to continuous ration cuts and diminishing donor funding. With better knowledge of how to grow different types of crops than the hosting community, as well as the right investments and an environment that makes it easy for them to grow and sell crops locally and across borders, refugees can transform the production landscape by strengthening market-oriented action. They can also contribute to making local communities resilient and self-reliant and help facilitate the diffusion of innovative solutions. The study identifies strategies, soil health management, further analysis of enablers and inhibitors of diverse crop varieties, market performance, and policy as areas for future research and development.*

Keywords: *Agriculture, Crops, Markets, Food security, Nutrition, Contract farming, Climate change, and Technology.*

I. INTRODUCTION

Kenya's economy is based mostly on agriculture, which generates over 33% of the country's GDP and employs over 40% of the workforce, including 70% of those living in rural areas. Most of the population's food, income, and nutrition come from agriculture. The public, private, and civil society sectors strive to enhance market system sustainability, augment agriculture-driven economic growth, and improve food security outcomes by encouraging public-private sector collaboration and fortifying the resilience of agricultural investments and performance outcomes. However, there are substantial obstacles that restrict agriculture's ability to contribute economically to the nation and the populations that depend on it. These barriers impact the productivity of agricultural investments and the efficiency of markets. Low efforts in crop production and poor market value outputs in Turkana contribute to the daily poverty and hunger experienced by most populations.

Local agricultural value chains are becoming less competitive in the local and cross-border markets. This situation is attributable to the persistent food insecurity that hurts the well-being of the Turkana population. Turkana is renowned for its complex systems and mostly the traditional methods of growing crops. With the constant efforts to ensure food security and the growing need for more crop variety for improved food production, large sums of money have been invested over time by multiple development partners and the government to optimize agriculture, especially in areas that receive significant rainfall or are put under irrigation. However, Turkana's food, income, and nutrition insecurity is likely to persist and have a long-term impact on the region's economy due to its vastness, hardships, and myriad of challenges causing low productivity and sustainability of agricultural investments. Considering this scenario, diversifying agriculture for the attainment of enough food for consumption and sale would help Turkana and its displacement setting address the food security gaps and boost the local economy by making the populace and the county better, more resilient, and more food-sufficient.

Turkana harbors Kenya's second-largest refugee settlement. According to UNHCR data for May 2024 (Kakuma floods assessment report), the Kakuma camp and Kalobeyei integrated settlement are home to around 283,000 refugees and asylum seekers. Food assistance from humanitarian organizations is the primary source of food security in the refugee environment. However, inadequate food supplies and a rapidly growing refugee population are causing a paradigm shift in food assistance systems, including the need for self-reliance and the proposed refugee-targeted assistance. Self-reliance is one of the humanitarian socioeconomic development approaches used to help refugees and vulnerable members of the host community find ways to fend for themselves. Integration is a pillar of self-reliance that brings refugees and host populations together to engage in various socioeconomic activities while breaking down barriers that may impede human coexistence and fostering commonalities that can assist populations in displacement settings to improve their well-being jointly. Agriculture is one of the most popular livelihood options for refugees.

Diverse food crops are planted to supplement the food aid provided to refugees, including aid interventions that are necessary for nutrition and income. The aridity of Turkana, lengthy droughts, low rainfall, high agricultural input costs, and limited access to finance and equipment are among the most significant hurdles to food production and marketing in the displacement (refugee) setting. Without agriculture in Turkana's displacement situation, food and nutrition insecurity would reach crisis proportions. Thanks to the commitments of the Turkana County Government, particularly the Department of Agriculture, UN organizations, civil society, Refugee-Led Organizations (RLOs), community and faith-based organizations, and private sector players for exploring pathways for making agriculture create solutions to the challenges of food, income, and nutrition security for the benefit of the vulnerable populations in Turkana.

II. LITERATURE REVIEW

A) Food and Nutrition Security Globally

The Sustainable Development Goals (SDGs) are a set of targets that also promote sustainable agriculture, achieving food security, improving nutrition, and ending hunger. According to Galli and Watters (2019), food systems and SDGs can be achieved if governments in the world can bridge policy gaps. However, the globe is not on course to achieve "zero hunger" by 2030 because of issues like economic challenges, climate change, and political situations. As per findings in Agostoni et al. (2023), there is a strong link between climate change and food systems, and its adverse effects are reducing the quantity and quality of food produced, increasing malnutrition, poverty, and income insecurity. Changes must be made quickly, including modelling climate change's impacts on crop production for food security as per recommendations in Bindi et al. (2015) vital for restoring the state of food security and nutrition in the world.

It is also pinpointed in the Adenle et al. (2019) study on sustainable agriculture and food security in Africa that the rising rates of inequality challenge sustainable food security and nutrition, the high cost of nutrient-dense foods, and the intensifying patterns of food insecurity and malnutrition. That is why Galli and Watters's (2019) study also emphasizes the need for developing holistic food security policies that strengthen agrifood systems that states and economic regions can use to increase food production outputs and market vibrancy. In most countries in Africa, government investments in agriculture and food systems transformation are hampered by the present recession and turmoil. Malnutrition reached 9.8% globally in 2021, and 800 million people are predicted to go hungry by 2030. It is estimated that 2.37 billion people globally lack enough food, and there has been a worsening of the gender gap in the food insecurity sector (Rosenthal et al., 2021). According to Fanzo (2014), strengthening the engagement of food and health systems is critical for improving food and nutrition security, where a switch to producing and consuming nutritious foods might reduce healthcare expenditures, which are projected to reach $1.3 trillion annually by 2030.

B) Strategic Food Security Interventions

With strategic interventions in the food environment, political economy, and supply chain systems, it is found in Di Pima et al. (2023) to improve the implementation and scale-up of nutrition-sensitive agriculture, which can enable middle- and low-income countries to increase their food production and access capabilities. Vågsholm et al. (2020) encourage governments

and food security actors to make rightful tradeoffs to ensure food security intents, food safety, and sustainability are guiding food production and marketing efforts. It is also emphasized by Liguori et al. (2022) that achieving food quality and safety will positively impact the performance of markets and consumption of agricultural products. The Poirier and Neufeld (2023) study on promoting community-based indigenous food sovereignty encourages governments, especially in poor countries and vulnerable human contexts, to prioritize children's nutrition, lower food costs, help small-scale farmers, integrate nutrition into agriculture, and encourage behavioral change for better food diversity and consumption.

Launched in 2012, the Zero Hunger Challenge seeks to end hunger by guaranteeing universal access to food, promoting sustainable food systems, and increasing smallholder productivity and income. As per Namany et al. (2020) study on investing in sustainable food security through better decision-making processes, food access is impeded by several variables, such as food safety, poverty, socioeconomic situations, and transportation problems. Odeku's (2013) study, which recognizes global climate change as a threat to food security, recommends the application of strategic actions to double agricultural productivity, warrant sustainable food production, boost agricultural investment, remove trade and market entry barriers, and ensure that food commodity markets operate as intended.

C) Sustainability of Food Security Measures

The study by Zhang et al. (2022) found that investing in the food sector and building it through the circular economy model (huge investments in production and consumption) would sustain food production and increase consumption. The study by Mattas et al. (2021) also underscores the need for strengthening the sustainability of food supply chains through sensible, competitive, and sustainable policies. To achieve such milestones, governments and development partners need to increase food production, enhance the functionality of markets, lower the price of nutrient-dense foods, and increase food availability and access at household levels. Rosenthal et al. (2021) study emphasizes that building robust and secure agri-food systems can be a means of food security and public health linkages ensuring that everyone has access to inexpensive, wholesome food and diets.

As a result of persistent drought, especially in sub-Saharan Africa, low agricultural output, high food costs, declining income options in rural areas, stagnating earnings in urban areas, and impoverished households, according to findings in Abdullah et al. (2019) and Agostoni et al. (2023) increase the effects of food insecurity of which one of them is acute malnutrition. Anno et al. (2023), using the case of the Kakuma camp and Kalobeyei integrated settlement regarding the success of the United Nations Food and Agriculture Organization (FAO) Agri nutrition programme, affirm the possibilities of agriculture increasing access to food and nutrition in the displacement settings. This is realized through strategic interventions that target building the resilience and the self-reliance of refugees and hosting communities to maximize the socioeconomic transformation opportunities provided in the Turkana County development blueprint (CIDP), Kalobeyei Integrated Socioeconomic Development Plan (KISEDP) and Socioeconomic Hubs for Integrated Refugee Inclusion in Kenya (SHIRIKA Plan).

D) Theoretical Framework

Transforming agriculture through innovations, as aimed at by this research, is an intent grounded in the Diffusion of Innovations (DOI) Theory developed by E. M. Rogers in 1962. As one of the oldest social science theories, DOI has positively impacted the adoption of innovations in sociology, engineering, economics, agriculture, politics, health, and behavioral sciences, among other development spheres. The theory enables the communication of ideas and how products diffuse through a specific population or social system (Dearing and Cox, 2018). It recognizes people as part of a social system who can adopt new ideas, transform their behavior, consume products, or make use of innovations they did not appreciate in the first place. The theory shows that people are adopters to the ideas including making use of them differently according to behaviors they associate with such innovations. Therefore, diffusion is possible since the adoption of innovations does not happen simultaneously in a social system where people's characteristics on adoption of ideas are different.

The DOI theory presents adopter categories where innovators are the first to buy the ideas. They are interested in new ideas. The early adopters represent opinion leaders who are aware of the need to change and are comfortable adopting new ideas. The early majority only need evidence about the workability of the innovation to adopt, and the late majority people are skeptical of change, while laggards are bound by tradition and are very conservative, are skeptical of change and are hard to change. Many factors influence the adoption of an innovation. These include relative advantage, where innovation is better than products it's supposed to replace compatibility; where innovation is consistent with the values and needs of potential adopters; complexity, which includes difficulty in understanding innovation, traceability, meaning the extent of testing experimentation before adoption and observation which is the extent to which the innovation provides tangible results (Enyia and Nwuche, 2020). The percentages of the adoption of innovations as per DOI theory are presented in the diagram below.

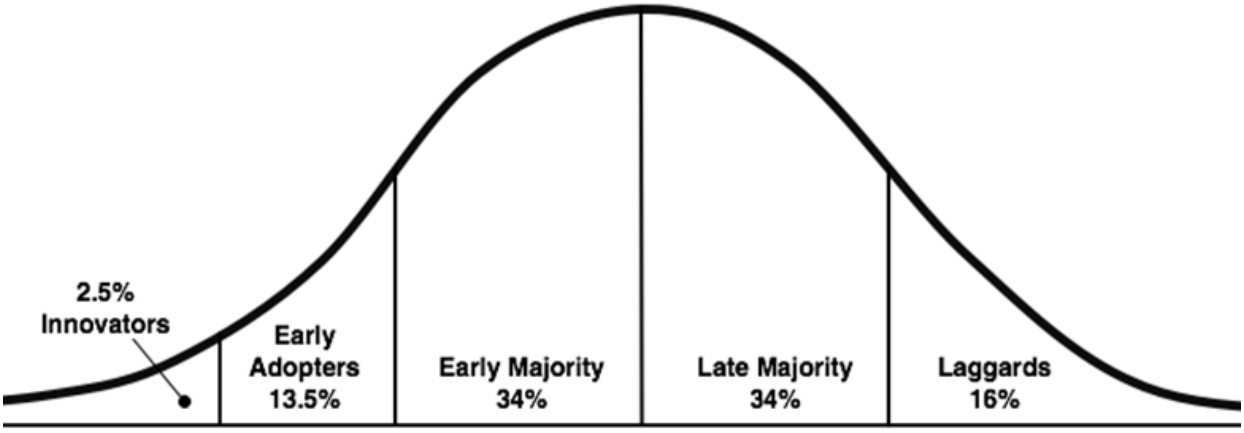

Figure 1: Diffusion of Innovations (DOI) Theory
Source: *http://blog.leanmonitor.com/early-adopters-allies-launching-product/*

III. RESEARCH METHODOLOGY

The study employed an exploratory research design and a mixed methods approach to systematically gather and analyze data on the status of agriculture and food security in Turkana. The study specifically examined the performance, shortcomings, and obstacles within the agriculture sub-sector while also identifying potential avenues for expanding field, horticulture, and cash crop production and marketing. The study was conducted in the six sub-counties of Turkana: Loima, Turkana West, Turkana South, Turkana Central, Turkana East, and Turkana North. A total of 40 people depicting diverse expertise and experience in agriculture and associated fields were purposefully selected through a rigorous process to contribute theoretical and practical insights about the study.

A total of 126 individuals who are farmers, producers, agribusiness groups, and community extension focal points were selected randomly from all regions where crops are produced and marketed. Semi-structured questions were administered to study participants, which included supplementary information generated by scoring algorithms, ranking, and visualization tools. The resultant data was cross-referenced with direct observations, secondary data, and existing literature. The graphic below displays the participatory data collection tools utilized.

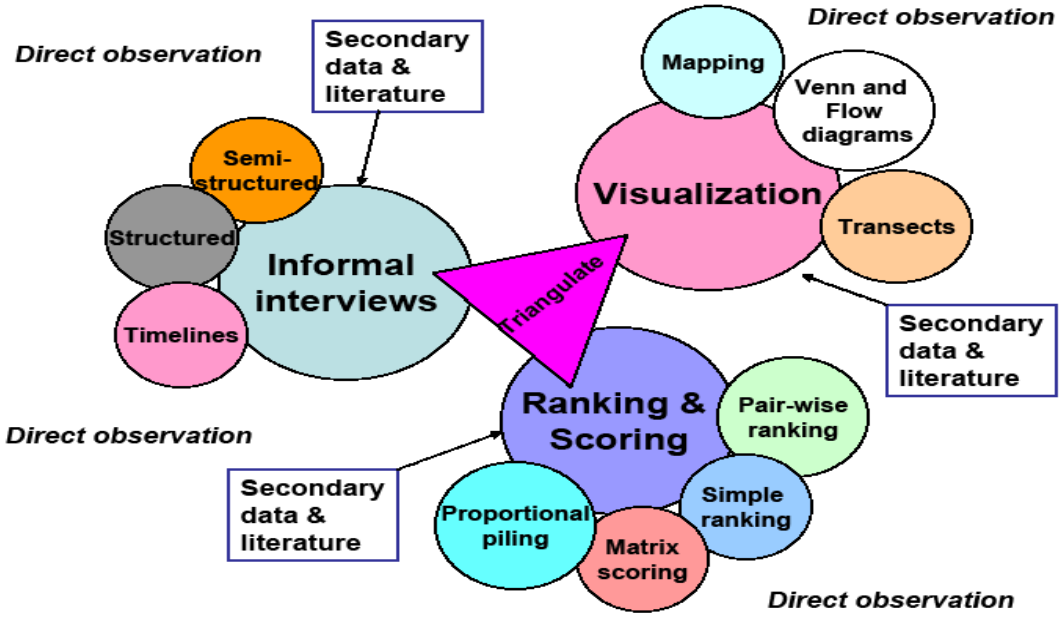

Figure 2: Participatory data collection techniques applied

III. RESULTS AND DISCUSSION

A) State of Food Security and Livelihoods in Turkana

The knowledge found in publications about Turkana shows that the area lies within Kenya's ecological zones 5, 6, and 7. The land size is 77,000 $km^{2,}$ with an estimated population of 1,022,793, where 49.4% is female (KNBS, 2022). The land is about 65% very arid, 29% arid, 3% semi-arid, and 3% as other lands. The area is known for being hot and relatively dry land throughout seasons, with an average rainfall of about 150 - 550 mm. Evapotranspiration rates are also very high, ranging from 1650 – 2800 mm/year, with challenges of limited water and low agricultural productivity affecting the area's food basket (KNBS, 2023). Turkana has 7 fully operational sub-countries, i.e., Turkana Central, Turkana South, Loima, Turkana East, Turkana West, Turkana North, and Kibish. Four additional sub-counties were created, which are undergoing processes of operationalization i.e., Suguta, Lokiriama, Aroo, and Lokichoggio.

Figure 3: Kenya's map showing Turkana

The Turkana livelihoods zones are categorized into four where pastoral is 60%, agro-pastoral 20%, fishing 12%, and formal employment 8%. In Turkana, livestock production is the main source of cash. It accounts for 91% of all cash held by households. Petty trade brings 3% of cash, while hunting and gathering brings about 2%. Regarding food consumed in Turkana, food crop production contributes 40%, livestock production 25%, and cash income about 10%. In fishing livelihood zones, fishing makes up 54% of total household cash income, while livestock production brings in 18% and casual wage labor 10%. The overall poverty incidence of Turkana is 79.4%, hardcore poverty incidence is 45%, and food security incidence is 64% (KNBS, 2021). The figures below show the classification of Kenya's land and livelihood zones of Turkana.

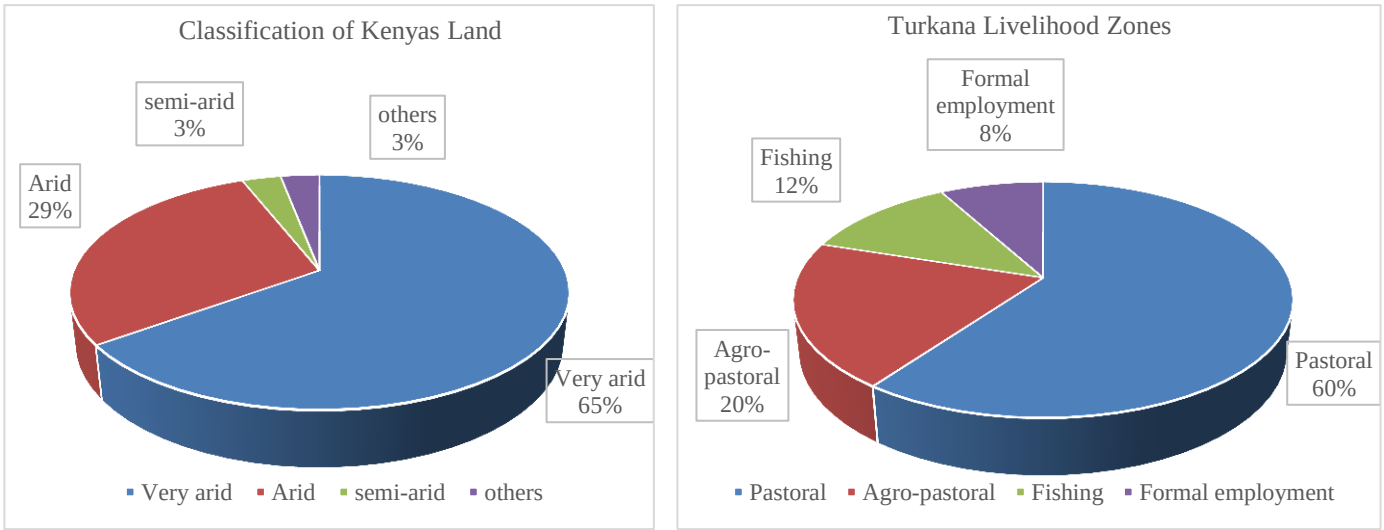

Figure 4: Kenya's land classification and Turkana livelihood zones

The Turkana rainfall pattern is bimodal, where long rains are experienced from March to May (MAM season) and short rains from October to December (OND season). Due to climate variability and unpredictability of weather, rainy seasons in Turkana are not regular. The failure of rainy seasons is frequent and has huge ramifications not only for crop and livestock production but also for the performance of markets and environmental recovery. With extreme food commodity prices, most people live below the poverty line. Availability of food at the household level and affordability in the market are the main drivers of food security in Turkana. In addition to crop production through irrigated and rain-fed agriculture and the trading of agricultural commodities supplied to Turkana from other agriculture potential regions of Kenya, crop production also means an increase in livestock forage from the farm remains. Mixed-crop farming enables the growing of livestock feed crops such as pasture and fodder varieties. These production and market opportunities have a ripple effect on market supplies, trading volumes, market prices, terms of trade, and income sources for farmers, traders, and households.

The findings on the state of food security in Turkana attribute the severe food insecurity to harsh agroecological zones of the area, which favour more livestock production through extensive and possibly semi-intensive systems. While indigenous livestock species adapt and resist harsh daily weather conditions, most crop varieties don't do optimally in the area. Climatic variability and two rainy seasons, which are increasingly becoming unpredictable in timing and amount of rainfall, including consistency of failed rainy season, continue diminishing the reliability of rainfed agriculture. As a result, it is extremely difficult to project production seasons thus affecting the planning and investments deployed to enhance food production.

The potential for crop production in Turkana remains significant. This can be realized through an increase in irrigated agriculture facilitated by access to underground water resources, harvesting of surface run-offs, and creating in situ water harvesting structures within the farming areas. Enriching farm ecosystems and installation of the most economical irrigation technologies will be a paradigm shift in the efficiency of food production in Turkana. This area depends solely on rainfall to grow food. Maximization of livelihood zones and livelihood opportunities, i.e., pastoral, agro-pastoral, fisheries, and wage labour, can supplement crop production efforts and help make food and income available even during dry seasons.

B) Arable Land in Turkana and Crop Potency

An estimated 2.5 million hectares of arable land exist in Turkana, and around 30 percent of the county's soil is regarded as moderately good for agricultural development. Under rain-fed and irrigated agricultural practices, crops are grown. There are 51 irrigation systems in the county, amounting to 6,500 acres and sustaining about 27,500 households. Along river Turkwell in Turkana South, Loima, and Turkana Central Sub counties, as well as the river Kerio in Turkana East and Turkana Central, irrigated agriculture is primarily the mode of crop production. Boreholes, shallow wells, and water pans are other sources of water for crop production. Maize, sorghum, cowpeas, green grams, groundnut, fruits (mangoes, pawpaw, bananas, citrus, and guavas), and vegetables are the primary crops (kales, spinach, amaranths, black nightshade, spider plant, capsicum, tomato, watermelon, butternut, pumpkin leaves). The average amount of agricultural land per family is 0.20 hectares. According to the Turkana County Agriculture Directorate, approximately 7,245 hectares are available for crop production, where 5,788 hectares (80%) are put under crops during long rains season and 1,457 hectares (20%) under crops during short rains. The study also found that invasive plant species colonize thousands of hectares of arable land in Turkana's high agricultural potential, and the efforts to reclaim them are too negligible and not coordinated.

Turkana has a sizable amount of arable land. When used properly, it can yield surplus food for both local and foreign markets in addition to food for domestic usage. Factors identified by the study as critical to agriculture and food security include Turkana's irrigation schemes performing below optimal levels due to low investments, particularly in water supply systems, low supply of production inputs, low levels of mechanized farming, and farmers' emphasis on subsistence farming. In Turkana, agroecologies that get irrigation and considerable rain can sustain the development and yield of numerous food and income crops. Technology transfers and research are recognized as important facilitators that not only pinpoint areas for innovation but also reinforce best practices and knowledge for maximum output. Despite having a sizable quantity of land for agriculture, most farmers are the representatives of their households. Crop farming done in this individualized manner does not maximize agricultural output or take advantage of economies of scale. Entrepreneurial farmer organizations with limited resources reduce the ability of local farmers to cultivate crops on a large scale, aggregate yields to meet market demands, and improve their contract farming capabilities.

C) Water and Food Security

The water resources that are available for domestic and small-scale agriculture use in Turkana include boreholes, shallow wells, flowing rivers, hand-dug river wells, lakes and swamps, water pans, earth dams, rock catchments, and piped water. The yield of most of these water sources is limited, except for flowing rivers that can irrigate large open crop fields and water harvesting structures that can primarily irrigate vegetable crops. Most study participants viewed piped water as uneconomical and costly, even for a kitchen garden, due to its metered and billed nature. Due to the high cost of accessing water, the high water demand, the inability to produce enough food because of limited water, and expensive coping strategies,

Turkana, over a long period is classified as a crisis area. An average of 40% of the population exhibits poor food consumption scores, with the majority requiring relief food and non-food interventions.

According to Rome's 2009 World Summit on Food Security, "Food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life." Four pillars anchor access to food: availability (adequate quantities), access (households getting food), utilization (consumption to meet dietary needs), and stability (continuous availability of food). The absence or disruption of any of these food security pillars means food-insecure nations and communities, and the consequences are overwhelming. Turkana lacks the elements that guarantee food security. The study affirms that without sustainable approaches and investments for food security in Turkana, accessing and sustaining the food supply in Turkana will be a great challenge to the well-being of populations, especially the growing and productive human categories.

D) Performance of Different Crop Categories in Turkana

a. Field Crops

The study found that open field crops, either through irrigated agriculture or rainfed, are the main mode of crop production in Turkana, which populations know better and exercise in large numbers. Despite the ability of the field crop system to produce food and attract incomes for farmers, the inherent challenges and field crop production gaps in Turkana make it inefficient, low-yielding, and unsustainable. The overriding gap identified by over 80% of study participants is subsistence farming, which aims at producing food for household use, a system restricting agriculture to less capital requirements, limited use of the available factors of production, and weakening market access intentions. The main crops grown on open fields in the order of priority are sorghum, assorted vegetables, pulses, maize, and cucurbits (watermelons, pumpkins, and butternuts). Almost all crop varieties, even those that are strictly for production under horticultural facilities or for nurturing in special setups such as plant nurseries, most farmers plant directly in the open fields.

The identified gaps for open-field agriculture include limited research to structure, organize, and commercialize open-field farming, undetermined crop value chains for open-field farming, unpredictability of rainfall coupled with failed crop seasons, huge agricultural investment costs, and diseconomies of scale. Limited Climate-smart and Conservation agriculture knowledge, introduction of insignificant drought-resistant crop cultivars, and undetermined seed selection, seed rate, and seed requirements for the county affect field crop output throughout seasons. Also, numerous standard agronomic practices and techniques are not applied to scale, and long-time use of traditional planting, harvesting, and storage methods, limited soil health management practices, limited water and inadequate systems of application, and soil and water acidity and alkalinity affect the performance of field crops in irrigation schemes despite considerable amount of water. Constrained transport and high costs associated with access to markets, post-harvest losses due to aflatoxin and mycotoxin threat, high crop yield perishability, crop sensitivity to weather conditions, risk of loss of value, limited value addition and processing, less marketing, and poor market linkages hinder the maximization of field crop production and marketing in Turkana.

The study also found diminishing agricultural land due to invasive species menace, e.g., Prosopis juliflora, weeds, high cost of eradicating invasive plants, inadequate irrigation infrastructure, and in some areas not fully utilized, and poor water conveyance hinders even the growing of easy-to-grow and drought tolerant crops. There is overdependence on free inputs such as seeds and tools from government and civil society, limited use of certified seeds, no community seed system, and agribusiness concepts not fully disseminated and applied, including contract farming, which is not yet exercised in Turkana. Subsistence farming and small-scale farm operation at the household level remain a huge hurdle for the commercialization of open-field agriculture. Those few farmers attempting to commercialize their agriculture efforts face capital-related challenges, and they constantly request subsidies, grants, loans, and equipment to help their agricultural endeavors. Farmer extension services are still limited due to the low number of personnel in the field against a huge number of farmers in Turkana. As a result, the capacity building of farmers in the field remains limited, and their knowledge, skills, and attitudes on best crop farming practices and abilities to realize the economic benefits of crop value chains remain poor.

Figure 3: Field crop (sorghum) in Turkana

b. Horticulture production

Horticulture is identified as one of the crucial features of sustainable agriculture in Turkana and the form that is implemented involves the use of shade nets and greenhouses fitted with irrigation technologies such as drip and bucket systems. Many farmers in different crop production settings, homesteads included, grow horticultural crops in the open field. Hydroponics technology, although new, is another upcoming horticulture production technology, especially by the private sector. The leading in the county is Hydroponics Africa Limited. In the displacement context (Kakuma and Kalobeyei), kitchen gardening is done using dryland farming technologies that are economical on land, water, and labor use. These technologies involve sunken beds that are widely used in displacement settings, Zai pit technology, organoponics, wick irrigation systems, vertical gardens, and recycling of household wastewater introduced and disseminated by the United Nations Food and Agriculture Organization (FAO) in collaboration with the Turkana County Department of Agriculture. These technologies are being disseminated further by many agencies supporting agriculture for livelihoods in the refugees and hosting community settings in Turkana.

Horticultural production, according to most study participants, is impeded by insect pests, plant diseases, harsh environmental conditions, and mineral deficiencies. Adoption of horticulture production techniques is very slow and that is why food commodity markets in the county are flooded with vegetables supplied from other counties (mainly Tran Zoia and Uasin Gishu). The drip system is the most used water conveyance system in many greenhouses and shade-netted farms. However, due to the strict economic use of water, drip lines are routinely altered (pricking of drip lines), especially in refugee settings. There is limited availability of horticultural seeds locally, and prices are high. Inorganic manure is low in supply and equally costly. Farmyard manure is increasingly expensive for refugee farmers because they are not yet allowed to keep small and large stocks. So they must buy farmyard manure from host community livestock keepers. In the county, due to limited water and systems of accessing and conveying it, horticultural production is becoming biannual and annual as horticulture production is supposed to be season-long.

Limited post-harvest management technologies, such as information on market access, vegetable drying, value addition, processing, and cold chain infrastructure (modern and locally made refrigerators), lead to losses due to the perishable nature of vegetables. Certified seeds are key to the success of horticultural production. Limited stockiest selling certified horticulture seeds, limited access to horticultural production inputs in the county, and insufficient research on specific types of horticultural crops to be grown in Turkana, irrigation technologies and securing the local market are other important challenges affecting the sub-sector. Soil and water salinity have an impact on the quality and market preference of vegetables grown in Turkana, especially in irrigation schemes. The value addition and processing of local vegetables, especially kale and spinach, which are high in demand, would increase their consumption in the market.

Figure 4: Horticulture production in Kalobeyei integrated settlement (EUTF -KISEDP- funded project)

c. Cash crop production and contract farming

Cash crops grown for sale on the market or export have not been explored in Turkana. Crops like cotton, pepper, groundnut, dates, and cucurbits were grown, but yield outputs haven't made them cash crops. The inhibiting gaps identified include limited knowledge of cash crops, lack of investments for successful production and marketing, and the fact that many crops grown are traditionally food crops. It is also established that there is no substantial study done in the county for cash crop farming, to determine the agroecological requirements and production and market access factors for each possible cash crop. It is a challenge to get the recommended seeds for cash crops as demanded by the market. Knowledge of the management of cash crops is still very low in Turkana. The study, however, established that the groundnut production enterprise implemented by the United Nations Food and Agriculture Organization (FAO) in collaboration with the Turkana County Department of Agriculture is causing huge enlightenment on the critical pillars of cash crop production, enterprise management, and contract farming as farmers have sold their produce to private investor peanut processing companies.

Crops insurance and risk management measures are not taken into consideration for the leverage of cash crops in the county. Inputs and factors of production are still limited to facilitate the scale, potentiality, and economics of cash crop production and marketing. Capacities of local farmers to act as contract farmers, enter into contract farming agreements on their own with the private sector players, limited guarantees, their ability to supply the required product thresholds, meet the quality standards, and sustain business engagements are still limited. Maximization of cash crop farming in Turkana and pricing of products is expected to be a challenge in the long-term future because the pricing of cash crops in Turkana can be low due to limited competition and quality issues.

Limited transport and entrepreneurs' distance from markets may lead to an imbalance in demand and supply market forces, leading to a market deficit. The lack of a cash crop farming strategy for Turkana presents a policy gap that will not only hinder the production of cash crops but also affect their marketing. The study notes that through the Kakuma Kalobeyei Challenge Fund (KKCF), an initiative of the IFC-World Bank Group, several agricultural investors have been funded to establish agricultural businesses in Turkana with a strong focus on the market. This depicts that with access to finance, investors can be attracted, and cash crop farming may become a reality.

Figure 5: Groundnut, a cash crop grown in Turkana (FAO's IKF-funded project)

E) Solutions for addressing Turkana's agricultural gaps and challenges

a. Field crop production and marketing

To realize robust and beneficial field crops in Turkana, the study identified research intensification, support for local variety germplasm characterization and commercialization, and strengthening the application of Conservation Agriculture (CA) and Climate Smart Agriculture (CSA) through hands-on learning as critical for adoption and replication of agricultural technologies and practices. Soil analysis for soil moisture, salinity, alkalinity, nutrients, and soil structure as a determination of the agroecological requirements of field crops is essential. Development of agricultural water structures, including water pans, rock catchments, sand and sub-surface dams, flood-based irrigation investments, etc., would diversify crop production systems in Turkana. Implementation of transport and storage infrastructure at each prospective production site, development and implementation of a sustainable communal seed system as an enterprise, and sustainably making quality seeds available to all farmer categories in all seasons would sustainably address the seed deficit challenge.

Elimination of invading plants, i.e., Prosopis j. and weeds, development of an IPM (Integrated Pest Management) plan and Plant Health Clinics, and the government of Turkana, civil society, and the private sector identifying important agricultural interventions and commit the necessary resources to achieve significant outcomes will increase socioeconomic benefits from agriculture. Stakeholder training on post-harvest handling, value addition, public health, crop production, and marketing consistency will help reinforce efforts toward market access and season-long food security. Further training on agronomy, Good Agricultural Practices (GAP), and agribusiness for farmers, promotion of youth-friendly ideas in agriculture and enterprise development, including access to finance, will entice more youth and women to take agriculture as a business. On-farm agricultural field days would help educate and empower farmers. Government and development partners' ability to establish, measure production output, and sustain crop and livestock insurance programmes and other forms of the safety net would leverage farmers and entrepreneurs from the challenges affecting crop production and marketing. All these gains can be sustained if extension services and training are embedded in community services for agriculture.

b. Horticultural production and marketing

To protect horticultural crops, as in Section E (a) above, the study equally identifies the installation of an Integrated Pest Management (IPM) system and Plant Health Clinics in every farming area with the support of non-chemical pest control techniques. Further, to realize meaningful horticultural farming, regular assessment of the irrigation systems, management of shade nets or greenhouses, and in situ water harvesting structures in cases of open-field vegetable production would optimize horticulture production in times of water stress and prolonged droughts. Incorporating solar dryers, processing and value-adding devices and technologies, cold chain (refrigeration), and storage facilities into horticulture production units and markets will promote aggregation, maintain consistent product supply, and sustain demand for horticultural products.

Developing the capabilities of farmers, vendors, and consumers about diverse horticulture production systems and value chains, providing transportation for horticulture products for timely market access and wider dissemination, and

utilizing the most advanced horticulture production technologies will improve production outputs and agri-entrepreneurs performance in the market. Reducing the use of labor-intensive practices, aligning farming practices with conservation agriculture, creating a community-based seed distribution management system for horticultural crops, and encouraging regional and local retailers to stock certified seeds accessible to farmers using affordable prices will equally revamp the efforts geared toward horticulture farming in Turkana. Empowering producer groups, youth, and women, and strengthening strategy for horticulture production will not only improve performance but also make horticultural enterprises more sustainable, resilient, profitable, and competitive.

c. Cash crops production and marketing

It is critically identified that training farmers and private sector players on cash crops and contract farming opportunities will enable them to transform and expand cash crop farming. Maximization of the emerging cash crops that the county has tested to be viable, e.g., pepper, cotton, high-value vegetables, groundnuts, and fruits, can increase the value of agriculture in the county. Community sensitization and capacity development programmes focus on transforming farmer knowledge, skills, and mindset from subsistence farming to diversified market-oriented cash crop farming. Value chain approach integration in agricultural programming will empower the pathways toward agricultural market capitalization and monetization of existing and potential cash crop markets.

Certified seeds for cash crops should be used through locally developed community-based seed systems or seed supply systems using local proprietors and vendors. To support farmers' access to farming inputs, there is a need to develop workable informal and formal financial systems that can facilitate financial flows among the cash crop development stakeholders. To do this, local farmers need to agree with investors on favorable terms and incentives to facilitate local embracement and sustainability of cash crop farming in Turkana. Further, building logistical and communication systems for local producers that can easily link them with the local and terminal markets is a strong pillar for success.

IV. IMPLICATIONS FOR APPLICATION

The study's output motivates the government and development partners to encourage the growth of various crop categories in Turkana. The study identifies the opportunities and challenges associated with growing different categories of crops, thereby guiding the development of strategies and risk management plans. The study's results would enlighten Turkana's stakeholders about the necessary steps to achieve food sufficiency in the county by promoting farmer resilience and household self-reliance. The study output will guide the development of capacity-building frameworks, which involve designing crop enterprises, training, and farmers' exposure, consolidating technical and extension teams' capabilities, attracting private sector players, and facilitating access to funds to realize the identified crop production projects.

The refugee communities, particularly those from the Great Lakes region, exhibit diversity in terms of knowledge, skills, and positive attitudes. They are more familiar with the three broad crop categories studied. Given the necessary production factors, such as a policy that encourages refugee participation in agriculture on a significant scale and the provision of access to markets beyond Turkana, there is a high probability that refugees can excel in the production of fields, horticulture, and cash crops. Despite the limitations of realizing these crop varieties, refugees continue to motivate the local populations about the possibility of growing different crops. They have transformed local populations, an outcome that adds to the benefits of integrating refugees with the host communities.

V. CONCLUSION

The study identifies the potentiality of agriculture in Turkana, whose agroecologies can support different categories of crops. These crops have a significant impact on the Turkana population's food, income, and nutritional security. Despite agriculture's potential as a production factor, much of the food consumed and traded originates from areas outside the county. These practices deplete local resources that could fuel the growth of agriculture, a significant contributor to the region's economy. Agriculture is the game changer in relief food, and it has remained the primary source of food for many vulnerable households in Turkana. In the displacement setting, where refugee households receive just a maintenance ration, agriculture makes families increase their food basket, increase their food diversity, enrich their daily diets, and accrue income from surplus sales. The enormous challenges identified to impede field crop, horticulture, and cash crop production necessitate a strategic approach to managing them while increasing opportunities to maximize the potential of crop categories in Turkana agroecologies.

Considering the growing hunger and poverty among the Turkana population, as well as the decreasing rations for the refugee population, the study concludes that crop production can serve as a catalyst for addressing the current food, income, and nutrition challenges. Therefore, a diverse range of partners should consider making the necessary investments in agricultural development. At the center of agricultural development is the capacity enhancement of human, physical, and monetary resources deployed based on policy. Turkana, like other drylands that have succeeded in making agriculture the

topmost sector of the economy, given the availability of factors of production and high demand for food and income, can equally make farming the backbone of the economy and livelihoods. The adoption of agricultural innovations also needs time to be realized. Transformation of farmer and stakeholder behaviors needs to continue so that, in the long run, more agricultural innovations can be adopted in Turkana.

VI. SCOPE FOR FUTURE RESEARCH

People in Turkana still primarily engage in agriculture for subsistence purposes. This mode of production exhibits aspects of food insecurity since the attainment of sustainable food security means people can produce enough to eat and sell. The transformation of Turkana's agricultural systems into market-oriented systems should be the focus of the research. Enablers and inhibitors of field, horticulture, and cash crops are another area of interest for research. Determination of these elements would make the production of different crop categories possible. Research is also required to understand the Turkana soil health and manage the quality and consumer preference of crop products from Turkana. To facilitate this, the Turkana agricultural stakeholders should conduct expanded research to help identify additional drought-tolerant and faster-maturing crops that refugees and vulnerable host community households can grow to bridge food security gaps, attract income, and improve nutrition in the context of displacement.

Disclaimer

The views stated in this article are those of the authors and do not necessarily represent those of any of the entities mentioned.

Interest Conflicts

All authors declare that they have no conflicts of interest whatsoever in this publication.

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VII. REFERENCES

[1] Abdullah, D. Z., Shah, T., Ali, S., Ahmad, W., Din, I. U., & Ilyas, A. (2019). Factors affecting household food security in rural Northern Hinterland of Pakistan. J. Saudi Soc. Agric. Sci. 18, 201–210. doi:10.1016/j.jssas.2017.05.003

[2] Anno, E. F., Ingutia, E. I., & Ejore, S. E. (2023). The Influence of Strategic Planning and Marketing on Private Sector Development in a Displacement Context: A Case Study of Agriculture and Markets in Kakuma and Kalobeyei, Turkana County, Kenya. *International Research Journal of Economics and Management Studies*, Vol. 2, No. 2, pp. 461-471. DOI: 10.56472/25835238/IRJEMS-V2I2P150

[3] Adenle, A. A., Wedig, K. & Azadi, H. (2019). Sustainable agriculture and food security in Africa: The role of innovative technologies and international organizations. Technology in Society, Volume 58(C). DOI: 10.1016/j.techsoc.2019.05.007

[4] Agostoni, C., Baglioni, M., La Vecchia, A., Molari, G. & Berti, C. (2023). Interlinkages between Climate Change and Food Systems: The Impact on Child Malnutrition-Narrative Review. Nutrients, 15(2), 416.

[5] Bindi, M., Palosuo, T., Trnka, M. & Semenov, M. (2015). Modeling climate change impacts on crop production for food security. Climate Research, 65, 3–5.

[6] Di Prima, S., Wright, E. P., Sharma, I. K., Syurina, E. & Broerse, J. (2022). Implementation and scale-up of nutrition-sensitive agriculture in low-and middle-income countries: a systematic review of what works, what doesn't work and why. Global Food Security, 32.

[7] Dearing, J. W., & Cox, J. G. (2018). Diffusion of Innovations Theory, Principles, and Practice. Health Affairs 32, No. 2: 183-190. doi: 10.1377/hlthaff.2017.1104

[8] Enyia, C. D., & Nwuche, C. A. (2020). Innovation: A catalyst for effective engagement in economic growth in challenging times. European Journal of Management and Marketing Studies. Vol. 5(4). 82-95. DOI: 10.46827/ejmms.v5i4.911

[9] Fanzo, J. (2014). Strengthening the engagement of food and health systems to improve nutrition security: Synthesis and overview of approaches to address malnutrition. Global food security, 3(3-4), 183-192.

[10] Galli, F. & Watters, R. (2019). Food systems and the SDGs: Bridging the policy gap. Rome: FAO.

[11] KNBS. (2021). Economic Survey 2021. ISBN: 978-9966-102-30-0. https://www.knbs.or.ke/wp-content/uploads/2021/09/Economic-Survey-2021.pdf

[12] KNBS. (2023). Economic Survey 2023. ISBN: 978-9914-49-490-7. https://www.knbs.or.ke/download/economic-survey-2023/

[13] Liguori, J., Trübswasser, U., Pradeilles, R., Le Port, A., Landais, E., Talsma, E. & Holdsworth, M. (2022). How do food safety concerns affect consumer behaviors and diets in low-and middle-income countries? A systematic review. Global Food Security, 35.

[14] Mattas, K., Tsakiridou, E., Karelakis, C., Lazaridou, D., Gorton, M., Filipović, J. & Veneziani, M. (2021). Strengthening the sustainability of European food chains through quality and procurement policies. Trends in Food Science & Technology, 120, 248-253.

[15] Namany, S., Govindan, R., Alfagih, L., McKay, G. & Al-Ansari, T. (2020). Sustainable food security decision-making: an agent-based modeling approach. Journal of Cleaner Production, 255.

[16] Odeku, K. O. (2013). Global climate change, the threat to food safety and poverty. Mediterranean Journal of Social Sciences, 4(14), 827–834.

[17] Poirier, B. & Neufeld, H. (2023). We Need to Live off the Land: An Exploration and Conceptualization of Community-Based Indigenous Food Sovereignty Experiences and Practices. International Journal of Environmental Research and Public Health, 20(5), 4627.

[18] Rosenthal, J. P., Quinn, M., Hatt, E. & Wallinga, D. (2021). Food systems and public health: Linkages to achieve healthier diets and healthier communities. Annual Review of Public Health, 42, 183-198.

[19] Vågsholm, I., Arzoomand, N. & Boqvist, S. (2020). Food Security, Safety, and Sustainability—Getting the Tradeoffs Right. Frontiers in Sustainable Food Systems, 4, 16.

[20] Zhang, Q., Dhir, A. & Kaur, P. (2022). Circular economy and the food sector: A systematic literature review. Sustainable Production and Consumption, 32, 655-668.