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Strategic Outcomes to Food Security Challenges in Dryland Areas: Transforming Agriculture From Subsistence Economy To Market-orientated Systems

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Abstract: In the majority of Kenya's arid regions, the predominant agricultural practice is subsistence farming. This study sought to examine the obstacles impeding the achievement of sustainable food security in arid regions by exploring potential strategies for advancing commercial agriculture. The study aimed to (i) examine opportunities for transforming subsistence agriculture in drylands, (ii) identify obstacles encumbering stakeholder efforts to achieve commercial agriculture in these regions, and (iii) ascertain strategic solutions for enhancing agricultural production, diversity, and capitalising on existing markets. The study was conducted in Turkana with reference to Marsabit, Samburu, and West Pokot counties in Kenya. It included 200 enterprising farmers and 40 government and development partners, picked randomly and purposely, respectively. The research employed a survey design utilising semi-structured questionnaires as the instruments for data collection. The study findings indicate that the subsistence nature of crop and livestock farming, inadequate research and technology, the absence of centralised meteorological and early warning systems, inefficient market development and access, and weak relationships between supply and demand in agricultural market systems are pivotal factors obstructing the transition of agriculture in drylands from a traditional economy to market-orientated systems. The study recommends educating local residents on the drawbacks of subsistence farming and offering alternatives for transitioning to commercial agriculture. It also advocates for the development of research and knowledge frameworks to incentivise local farmers, entrepreneurs, and policy organisations to commercialise crop and livestock farming, as well as encouraging all agricultural stakeholders to engage with Early Warning Systems and facilitate their coordination. Furthermore, dryland agroecologies must be enhanced to optimise available production resources through innovative agricultural practices and to improve farmers' market access by ensuring quality, quantity, efficient agribusiness frameworks, competitive product pricing, and consistent stakeholder engagement. The study suggests that anticipatory actions and durable solutions are prospective areas for future research to leverage and up-scale agriculture in the arid regions of Kenya.

Keywords: *Subsistence farming, commercial farming, technology development, early warning systems, market access, supply and demand forces, and community resilience.*

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1.0 Introduction

The phrase "subsistence economy" denotes a system wherein societies produce adequate amounts of goods and services for their own consumption and immediate use, with minimal or no surplus for trade. A substantial segment of this economy relies on natural resources and traditional practices, predominantly found in rural and indigenous regions. An understanding of subsistence economies is beneficial as it underscores the importance of self-sufficiency and sustainability in resource management. Although subsistence farming enhances access to fundamental food and nutrition, it lacks food diversity, nutritional quality, and may not yield sufficient quantity and quality to satisfy consumer demands. The farming system is marked by considerable disadvantages, including low productivity, restricted access to production inputs and markets, susceptibility to climate and environmental shocks, minimal income generation, limited diversification opportunities, and land degradation and deforestation, among others.

The absence of market-oriented agricultural intent, restricts application of technology and best practices, and insufficient awareness of the imperative for attaining sustainable food, income, and nutrition security are rendering subsistence farming outdated. In many locations, it is conducted without irrigation, which is essential for accurate watering, rainwater harvesting and greywater recycling are not implemented in regions of both water abundance and scarcity and disease and pest management practices are not integrated and conventional. The approach fails to account for the necessity of cover cropping and advanced agricultural practices like zero-tillage to maintain soil moisture and health. Subsistence farming in rugged terrains neglects contour farming, and community collaborations for equitable and sustainable resource and knowledge sharing are disregarded.

A market system is defined by private property, entrepreneurial freedom, individual choice, self-interest,

competition, market dynamics, pricing mechanisms, reliance on technology and capital goods, specialisation, monetary use, and a proactive yet constrained governmental role. In market-orientated agriculture, farming firms operate as businesses employing competitive, profitable, and sustainable models and techniques to achieve significant profits. Considering the varied dietary requirements and market demands of humanity, a transformative approach to agriculture in arid regions, incorporating livestock and opportunistic crop cultivation, should be used to achieve scalability in commercial farming. Consequently, drylands will serve as centres for agricultural production, utilising revenues from traditional agriculture to bolster the development of essential economic sectors and enhance the sustainability of dryland economies, foster human development, and strengthen resilience against the impacts of chronic hazards. It is therefore imperative to explore together with the local residents and larger agricultural actors the challenges, opportunities and transformative results of commercialising agriculture in areas where subsistence farming is the prime mode of food security.

2.0 Literature Review

2.1 Agriculture and Socioeconomic Development

2.1.1 Continental and Regional Food Security Contexts

The continent of Africa faces its most severe hunger crisis in decades whereby in 2025, over 282 million people are directly affected. To eradicate hunger according to the study by Poirier and Neufeld (2023) on ensuring food sufficiency for all, long-term solutions that are driven by the community and designed to withstand future crises and enable people to feed themselves without aid for future generations are required. The problem is not insurmountable, and it is possible to eradicate hunger. Millions of people are at risk of chronic hunger and malnutrition if global action is not taken to address the situation, which is being pushed by climate change, economic instability, poverty, and weak food chains.

Mattas et al. (2021) allude to the necessity of food security and market access solutions to be long-term, comprehensive, and resilient enough to withstand future shocks. The study by Enyia and Nwuche (2020) on innovation as a catalyst for effective engagement emphasise that resilient livelihoods, income diversification and community resilience building structures should be sustainable, systemic, locally led, market orientated and scalable. The success of these solutions is contingent upon the existence of policies and investments that are both flexible and long-term.

2.1.2 Strategic Approaches to Food Security

Strategic interventions in the food environment, political economics, and supply chain systems can improve food security efforts through agriculture, enabling countries with middle and low-incomes to improve food production and access. Vågsholm et al. (2020) recommend prioritizing food security objectives, food safety, and sustainability in food production and marketing programs. Poirier and Neufeld's (2023) research advocates for prioritizing child nutrition, lowering food costs, supporting small-scale farmers, and promoting behavioral changes for enhanced food diversity and consumption. Namany et al. (2020) highlight food availability challenges due to food safety, poverty, socioeconomic conditions, and transportation. Odeku (2013) advocates for strategic measures to improve agricultural productivity, guarantee sustainable food production, and ensure proper functioning of food commodity markets.

2.1.3 Defining Agricultural Potential in Drylands

The circular economy model can maintain food production while increasing demand in markets, according to Zhang et al. (2022). Sustainable, competitive, and reasonable policies are crucial for improving food supply chains. Governments and development partners should boost food production, improve market efficiency, reduce nutrient-rich food prices, and strengthen food availability and accessibility (Di Pima et al., 2023). Resilient agri-food systems can provide food security and public health, ensuring affordable and nutritious food.

According to the study by Liquori et al. (2022) on the need for insecure areas to increase food production and marketing, recurrent droughts in sub-Saharan Africa have negatively impacted agricultural productivity, leading to increased food costs, reduced economic opportunities, and perpetuated family poverty. Agriculture has the potential to improve access to food and nutrition in regions with arid conditions or displacement. This is affirmed in Namany et al. (2020) study on need for addressing poverty factors through strategic agricultural interventions capable of enhance resilience and self-sufficiency for populations facing food insecurity.

2.1.4 Agriculture, Climate Change, and the Local Economies

Agriculture is a global economic foundation, providing stability for trade and food supplies. However, climate change and food insecurity in Africa necessitate the integration of economies for improved production efficiency and consumer market stability. The study by Abdullah et al. (2019) underscore the need for well-designed agricultural interventions in dryland regions since expanding small-scale economies is crucial to address food shortages. According to Anno et al. (2023) on integrated food security systems and approaches, the needy communities and regions can develop good agricultural business cases that can create employment opportunities, promote sectoral growth, and facilitate community empowering through enhanced knowledge, skills, and mindset change.

Entrepreneurial efforts in agriculture and industry can contribute to food and economic security, but many producers still live in poverty due to limited access to market opportunities (Galli and Watters, 2019). It is also found in Anno et al. (2024) that sustainable agriculture is successful if well anchored on soil health and water management systems, biodiversity conservation, energy efficiency and social inclusiveness and ethical practices. These factors help modernize the sectors, improve production value, and manage risks and uncertainties.

To boost agricultural investments in climate change-impacted areas as per findings in Agostoni et al. (2023), robust strategic implementation networks are crucial. The key challenges to this action include lack of information on small-scale farming and poor food security techniques, which according to Abdullah et al. (2019) are addressed through commercial, profitable, and environmentally accountable solutions. Stakeholder engagement is essential for addressing food and economic insecurity and market components are necessary for sustainable growth in challenging agricultural environments (Namany et al. 2020; KNBS, 2023).

2.1.5 Agribusiness and Entrepreneurship in Drylands

Entrepreneurial efforts in agriculture and industry can contribute to food and economic security, but many crop and livestock producers still live in poverty due to limited access to market opportunities (Adenle et al., 2019). To achieve profitability and sustainability, strategic business decisions require reliable, proficient procedures, rapid technological advancements, investment evaluations, strategic planning, marketing, brand propositions, competitiveness, and risk management capabilities. These factors according to Rosenthal et al. (2021) study on the need for collective action in food security measures will help modernise the drylands economic sectors, improve production value, and manage the inherent risks and uncertainties.

To boost agricultural investments in climate change-impacted areas, Bindi et al. (2015) study on food security and nutrition pinpoints that robust strategic implementation networks are crucial to eliminate challenges such as lack of information on small-scale farming and food security techniques achievable through-market based, profitable, and environmentally accountable solutions. The study by Fanzo (2014) on food security as a means of improving human wellbeing emphasizes that agricultural stakeholder engagement is essential for addressing food and economic insecurity and for increasing opportunities for sustaining competiveness in agricultural markets.

3.0 Methodology

The study utilised a survey design to collect data from respondents in the chosen counties, with crop farmers and livestock keepers as primary respondents (N=200) and government and development partners as secondary respondents (N=40). The study participants were purposefully chosen from the potential agricultural regions of Turkana, Marsabit, West Pokot, and Samburu counties. Among the study participants, 142 (59%) were women and 106 (44%) were youths (aged under 35 years).

A semi-structured questionnaire was employed to gather data on the study's focal areas, namely subsistence farming, research and technology, early warning systems, market development and access, and the management of supply and demand market dynamics. A variety of informal interviews, visualisation, ranking, and scoring data gathering approaches (Figure 1) were used to enhance the implementation of the study instruments and the triangulation of the resulting data. The procedure for qualitative data analysis involved: data preparation and organization, data review and exploration, creation of codes and review into themes, and themes presented in a cohesive manner. The collected data was corroborated with the existing literature on the study themes and through stakeholder data evaluation workshops.

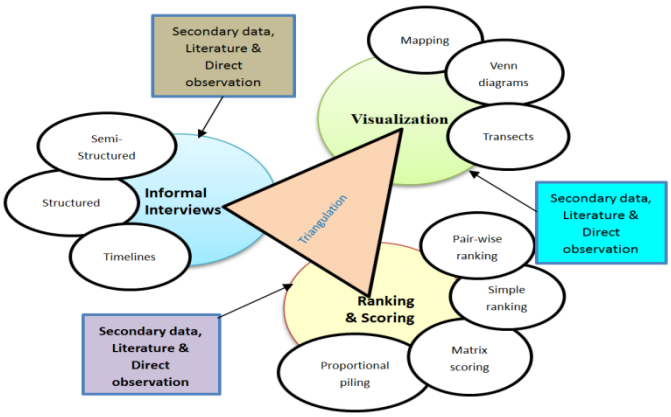

Figure 1: Participatory Rural Appraisal (PRA) techniques employed in the research study

4.0 Results and Discussion

4.1 Opportunities for Subsistence Agriculture Transformation in Drylands

4.1.1 Subsistence Nature of Crop and Livestock Farming

Based on the findings of the study, it was determined that the primary aim of agriculture in the majority of Kenya's drylands, as well as the largest portion of agriculture based on crops and livestock, was to provide for subsistence and to fulfil social values, such as marriages, rites of passage, and other community social events. Drylands, on the other hand, are the primary producers of livestock that is sold mostly in metropolitan markets. Due to the fact that these resources are produced primarily through the use of traditional techniques and procedures, their quality and competitiveness in urban markets are negatively impacted.

Even though the government and other development partners are working hard to expand agriculture in drylands, the progress that they are making is quite gradual. The ratio of expert personnel to farmers, particularly crop and livestock scientists, extension agents, and trainers, is 1:5,000, which is far higher than the recommended ratio of 1:400. This is due to the fact that the population is still growing and experts are extremely few. Therefore, the production and productivity of agriculture, particularly in dryland regions, is greatly impacted as a consequence of this. The figure below (Figure 2) shows dryland commercial horticultural producers for the market using shade-netted and drip irrigation technologies.

Figure 2: Commercial horticultural Farmers in Turkana

4.1.2 Limited Research and Technology Development

It is obvious that there is a lack of research on the kinds of animals and crops that are able to adapt to these drylands. Similar crop kinds, such as sorghum, maize, and vegetables, have been

cultivated for a considerable amount of time despite the limited availability of improved seeds. In terms of livestock, the Turkana, Rendille, Gabra, and Somali camel varieties, as well as the small East African goat, the black-headed Persian sheep, and the zebu cows, are the most kept in the study areas. There is a decline in the vitality and productivity of such breeds as a result of inbreeding and linebreeding, which are both contributing factors. The technique of production, known as herding, is responsible for these difficulties in livestock production. Herding allows animals to freely mingle with one another in the grazing area and at drinking spots, which often results in unregulated breeding and the transfer of inferior genes, diseases and parasites among the animals.

In spite of the fact that there are opportunities to enhance livestock breeds in drylands, such as the interbreeding of small East African goats with improved goat breeds like Galla goats and Boer goats, the introduction of the Dorper sheep breed to drylands, the introduction of Borana and Sahiwal cows to semi-arid regions, and the crossing of Turkana camels with Somali camels, which are larger in size, dryland ecologies are confronted with a decline in biodiversity as a result of prolonged droughts and the long-term effects of climate change. This, in turn, limits the ecological requirements of new breeds, which results in their poor performance.

4.1.3 Meteorological and Early Warning capacities

There is a lack of suitable meteorological infrastructure in the dryland regions, specifically in terms of weather forecasting stations, manpower, and equipment. In the majority of arid and semi-arid lands (ASALs), the subsistence nature of agriculture and animal production has been maintained due to the inability to analyse climatic information and make it available for farmers to use. This is because of the high degree of weather and climate unpredictability that exists in dryland regions. There is a lack of early warnings for everyone, and there is a lack of uniform data for the government and development partners to use when implementing agricultural initiatives in dryland areas. This is because there is insufficient climate information.

The majority of dryland farmers are illiterate, which contributes to the inadequacy of climate information. This, in turn, leads to the inefficient adoption of climate-smart agricultural practices, as well as the inability to initiate and sustain community-managed disaster risk reduction measures. These measures include the management of contingency and development plans for resilience. The study also reveals that despite the fact that some semi-arid regions experience favourable rainy seasons, these seasons are connected with a number of obstacles that are associated with agricultural and livestock production. These issues include soil erosion, extreme weather effects, pests, and diseases, among other things. The ability of local farmers to deal with these difficulties is limited and there is a lack of coordination among them.

4.1.4 Market Development and Access

It is clear that some subsistence farmers, particularly those located in semi-arid regions, are expanding the scale of their production by increasing the amount of land they farm, diversifying the types of crops they grow, engaging in mixed farming, increasing their access to water, employing conventional farming practices, and gaining access to improved production inputs and specialised labour. Even with all of these efforts, access to markets that are both competitive and sustainable continues to be a difficult obstacle. Seasonal markets are prevalent in dryland regions, and the bulk of these markets are controlled by farmers from high potential areas. These farmers are the primary suppliers and merchants in these markets.

Agricultural products that are produced locally are influenced by market preferences, which rank them according to the amount and quality of their production. As a result of this scenario, the competitive advantage that local farmers and traders have is being diminished, which is preventing them from securing a considerable market share in their respective native marketplaces. Both supply and demand forces have an impact on the livestock markets that are located in dryland areas.

When there is a lack of water and pasture, livestock will go to faraway places and cross international borders in order to find better conditions. The livestock supply in marketplaces is reduced as a result of this relocation. As a result of an increase in prices during dry periods, the demand for livestock from off-take marketplaces, also known as traders from tertiary and terminal markets, decreases, which results in losses for both local farmers and traders. The figure below (Figure 3) shows the emergence of abattoirs in the dryland areas creating market opportunities for commercial livestock farmers.

Figure 3: Community Managed Commercial Abattoir in Marsabit

4.1.5 Management of Supply and Demand market forces

In the drylands, market access, which refers to the powers of states, regions, and commercial organisations to sell products both inside and between targeted markets, is still restricted. Key elements of market access that were identified by the study as being obstacles to the commercialisation of agriculture in dryland regions of Kenya include the production output, which comprises both quality and quantity, capital resources for production, processing and transition to markets, trade barriers, compliance with regulations, and competition.

The research demonstrates that supply and demand are the most important factors in agricultural production and marketing especially in dryland regions. On the other hand, they are too complicated variables for the commercial farmers and business owners in the area to understand. Neither of these two variables has been thoroughly investigated to assist in determining the landscape of agricultural interventions in drylands and their connections to the market.

Despite the fact that the market in dryland areas has been dominated by external traders for a considerable amount of time, it continues to experience an increased rate of new entries. These

new entrants are traders of livestock and crop produce from Uganda, South Sudan, and Ethiopia. The consequences of this are that local competitive capacities continue to deteriorate, and that the purchasing and negotiating power of local entrepreneurs continues to decrease. The research highlights the significance of supply and demand market performance, which is essential for maintaining market access and competitiveness. As a result, it encourages farmers to shift their farming practices from subsistence farming to market-orientated farming operations and objectives.

4.2 Remedies for Agricultural Production and Marketing challenges

4.2.1 Improved Crop and Livestock Farming

According to the findings of the study, even though there is a scarcity of water for farming in drylands, the amount of land available, which is an essential component of agricultural output, is immense. Previous research has demonstrated that such lands, which have not been utilised to a significant degree, possess the potential to be fruitful for agricultural and livestock farming with little requirements for soil fertility inputs. The months of March, April, and May (MAM) have long rains, whereas the months of October, November, and December (OND) have short rainfall. This means that many arid and semi-arid regions of Kenya have two rainy seasons in a single year.

Farmers in arid and semi-arid regions have the ability to maximise their crop and livestock production, but this is contingent on the amount of rain that is anticipated to fall. Because of this, harvests will be increased, and there will be a significant surplus for the market. When combined with effective irrigation techniques, water collection, and economies of scale, it is possible to make the transition from subsistence farming to production that is focused on producing agricultural commodities for the market.

The utilisation of market standards as a means of directing the production of crops and livestock would not only enhance the quality and quantity of yields, but it will also enhance the availability of agricultural products originating from drylands in urban markets, thereby increasing their competitiveness and consumption. This will not only hasten the expansion of agricultural production in a dryland region, but it will also enhance the extension, training, and management resources available to farmers in order to meet the requirements of an expanding population.

4.2.2 Research and Technology Developments in Drylands

It is absolutely necessary to acquire scientific knowledge through research and technological advancements to liberate the potential of drylands in terms of both food security and market potential. It will be possible to revitalise and maintain agricultural output in a variety of climatic and weather situations if research is conducted on the suitable agricultural germplasms and livestock breeds that are produced using climate-smart technologies. Cereal grains have been used as seeds for a significant amount of time, particularly for cereal crops, despite the fact that there is the possibility of gaining access to improved and certified seeds.

Access to seeds is a problem that can be solved via community seed systems, which are a viable solution for the aim of ensuring sustainability. This will help to manage the usage of enhanced seeds and ensure that they are supplied to farmers throughout the seasons at rates that are affordable. Each irrigation system that includes seed producing units will support this regulation. The problem of livestock breeds deteriorating as a result of inbreeding and linebreeding, which leads to low production, can be effectively addressed by selective breeding and artificial insemination (AI). It is possible to use superior breeds that are able to adapt to drylands to revitalise the potential of indigenous breeds.

The study places an emphasis on the implementation of semi-intensive and intensive systems of livestock farming as a means of regulating breeding and inculcating a multitude of good livestock husbandry practices. These practices include timely animal health services to reduce the risk of disease and vectors, season-long production and conservation of nutrient-dense forages, and efficient breeding systems. Farmers, in conjunction with the government and members of civil society, can work together to enhance the agroecologies of drylands to ensure that the introduced crop and animal varieties are able to flourish in these areas. To meet the ecological requirements of the various crop types and livestock breeds, there should be an increase in biodiversity as well as water harvesting.

4.2.3 Weather Forecasting and Anticipatory Actions

There is a significant threat to agricultural production posed by the highly variable climate and the fast shifting weather patterns that occur in drylands. It is possible to reduce this difficulty by increasing the number of weather forecasting stations and workers rather than concentrating such capacities at the headquarters of the counties. By increasing the amount of knowledge available about the environment, agricultural initiatives will become more predictable, resulting in a more educated farmer and product consumers. Producing and disseminating climatic data in a timely manner will lead to an increase in the consumption of accurate information on the beginning and ending of rainy seasons, as well as the amount of rain that is received, which will inform the resource use plans and timeliness of farming activities.

The dryland regions that were utilised in this research project i.e., Turkana, Marsabit, Wet Pokot and Samburu have an average illiteracy rate of 75.3 percent. Increased literacy leads to an increase in the utilisation of the climate information that is accessible, as well as an increase in the participation of farmers in climate anticipatory efforts and long-term solutions to sustain agriculture. The implementation of workable community-managed contingency and development plans that stipulate the climate risks, such as hazards and disasters, the roles of farmers and agricultural stakeholders, the resources that are required, and monitoring frameworks are among the strategies that are designed to facilitate the delivery of anticipatory actions, long-term solutions, and risk mitigation and management systems.

4.2.4 Market Access and Competitiveness

In the study, fertile and abundant area for agricultural activities in drylands is taken into consideration as potential routes for increased production, the introduction of different and improved crop types, and livestock species. Any improvement in yields will result in an increase in the capability to access the market. The use of conventional farming practices through the implementation of technologies, access to enhanced production inputs, and competitiveness are all gates to prospective markets inside the country. Increasing the knowledge and financial resource capacities of local producers and merchants is a lasting solution to

the problem of external entrepreneurs having a dominant position in dryland marketplaces.

One of the most important factors that drives agriculture is the loyalty of the local consumers to the products that are produced in the drylands and which play a vital role in driving demand. To improve both the quality and quantity of agricultural products, the study highlights the importance of implementing techniques to restore the health of the soil and water, such as managing the salinity and acidity of the soil and amending them. If agricultural stakeholders are able to work towards achieving a balance in the relationship between supply and demand market dynamics, this will result in an increase in the affordability and consumerability of local products.

It is anticipated that the implementation of traditional livestock production systems will result in a reduction in the migration of livestock to distant locations in search of pasture and water, a rise in the supply of livestock in markets, the availability of tertiary merchants from external markets in the region, and the affordability of livestock and livestock products. The figure below (Figure 4) shows pastoralists women growing fodder for their livestock and sale. They also sell pasture seeds.

Figure 4: Commercial Pasture Producers and Traders in Lokichoggio, Turkana

5.0 Conclusion

The study concludes that Kenya's dryland agriculture faces challenges such as subsistence farming, limited research and technology development, inadequate meteorological infrastructure, poor market development and access strategies. Despite efforts to expand agriculture, progress is slow due to food demands of the rapidly growing population. Livestock breeds like small East African goats, and Turkana, Rendille, Gabra, and Somali camels are declining due to inbreeding and linebreeding. Meteorological and early warning capacities are lacking, leading to inefficient climate-smart practices and disaster risk reduction measures. Despite favourable rainy seasons, farmers face obstacles like soil erosion, extreme weather, pests, and diseases among others. Access to competitive markets remains a challenge, with seasonal markets and the imbalance in supply and demand forces impacting crops and livestock markets.

The study suggests several solutions to manage agricultural production and marketing challenges in drylands. Improving farming techniques, transitioning from subsistence farming to market-orientate production, and implementing climate-smart technology are crucial. Community seed systems, selective breeding, and intensive livestock farming systems can improve breeding practices. Increased weather forecasting and community-managed contingency plans can reduce threats to agricultural production. Improving market access and competitiveness, increasing local producers' knowledge and financial resources, and restoring soil and water health can improve the quality and quantity of goods. All factors of agricultural growth can be realised if investments are substantial, evidence-based, and augmented through agricultural planning and resource economies, facilitated sustainably by well-empowered, motivated, and progressive players.

6.0 Recommendations

This study has yielded the following strategic recommendations:

a. Subsistence farming is a traditional economic model that neglects the significance of monetary resources and goals essential for agricultural development. This agricultural method is unsustainable and renders dependent populations vulnerable to significant food, financial, and nutritional insecurity. In certain countries, economic regions and business contexts, subsistence farming is being discouraged to allow households and farmers to capitalise on conventional and commercial agriculture driven by market demands. Local residents must be educated about the drawbacks of subsistence farming while enhancing options for the direction and acceptance of market-orientated agricultural systems.

b. There exists a significant research and information deficiency in the majority of arid regions. Consequently, the so far implemented agricultural advancements in these regions have yielded insignificant results. Momentous deficiencies exist in the knowledge and capabilities of agricultural stakeholders in these regions, hindering their ability to implement changes that could enhance food production and foster a market economy necessary for making agriculture lucrative, competitive, and sustainable. The study thus advocates for the establishment of research and knowledge development frameworks essential for incentivising local farmers, agricultural entrepreneurs, and policy organisations to foster commercial agricultural investments in arid regions.

c. Due to the scarcity of meteorological data in arid regions, the study advocates for the decentralisation of meteorological stations and staff in agriculturally viable areas to ensure the prompt distribution of climate and weather information. Robust Early Warning Systems (EWS) should be created and institutionalised throughout various counties for implementation in conjunction with county agencies for disaster management and the National Drought Management Authority (NDMA). All farmers and their service providers must subscribe to the ratified EWS and utilise it as a means for community preparedness and response to existing threats and disasters.

d. The cultivation of same crop varieties and the maintenance of local livestock breeds restrict agricultural performance and commercialisation in arid regions. The study emphasises the necessity for the introduction of drought-resistant and high-yielding crop and livestock breeds. To ensure the prosperity of these breeds, it is essential to restore dryland agroecologies and enhance resource economic methods for the optimal utilisation of

available production variables while fostering innovations in agricultural practices.

e. Supply and demand are complex market variables that most local farmers and sector actors do not comprehend in terms of their functioning and interrelation. The study advocates for programs that enhance farmers' capacities to improve market access by ensuring the requisite quality and quantity of agricultural outputs, fortifying agribusiness frameworks that encompass efficient product aggregation and distribution mechanisms, establishing competitive pricing, and facilitating regular engagement with market stakeholders. These capabilities will enhance market intent and influence farmers' perceptions, perhaps facilitating the commercialisation of agricultural activities.

7.0 Areas For Future Research

The following are important areas for future research that are strategic in nature and have the potential to transform agriculture in dryland regions.

a. Carry out research studies on anticipatory actions that can be taken to lessen the effects of drought before it occurs or before its most severe effects to food security are experienced in the dryland areas.

b. Conduct research to determine the likely long-term effects of dryland agriculture and the functionality of markets as measures for long-term food security campaigns.

Disclaimer

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

Interest Conflicts

- The author declares no conflict of interest whatsoever in this publication.

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