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Toward Food Security in Africa

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Editorial

Introduction to Special Issue *Toward Food Security in Africa*

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Abstract: Living well below 10% of the global average income, 34% of humankind and 65% of Africans have less to spend on food each day than what USD 3 can buy in the United States. The resulting nutritional deficits cause severe health problems, especially for children whose physical and mental development they permanently impair. Governments promise reform – often – but have achieved no progress during the last decade. In fact, the rapid ecological harms they continue to facilitate contribute greatly to food insecurity. Focusing on Africa, the present volume discusses food insecurity: what it is, the forms it takes, its distribution and its evolution over time, its main drivers with emphasis on responsible parties, and viable reforms toward food security for all.

Keywords:
1. Food insecurity
2. Healthy diet
3. Measuring undernourishment
4. Nutritional deficits
5. Poverty
6. Seasonal hunger

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Edited by Anne Gongwe, Jean Mboma, and Florence Opondo, this Special Issue of Journal ASAP is dedicated to achieving secure access to adequate food, especially on the African continent. This goal has been widely endorsed for a long time. In our era, a highly prominent such endorsement occurred at the 1996 World Food Summit in Rome, where 186 governments, 112 of them represented by their Heads of State, made this solemn promise:

> "We pledge our political will and our common and national commitment to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015" (Rome Declaration 1996).

For the year of the World Food Summit, the UN Food and Agriculture Organization (FAO) reported 791.5 million chronically undernourished people worldwide, 193.6 million of them in Africa (FAO et al. 2011, 44). From that year (1996) forward, both numbers kept rising until, in the wake of the 2008-09 global food price crisis, the global number of chronically undernourished was on the verge of breaking above the 1-billion mark for the first time in human history. At this point, the FAO modified its definition of undernourishment with the result that the 1996 number was revised upward to 931 million and the 2009 figure downward to 867 million. With the new definition, a consistently rising count of undernourished people was transformed into a consistently declining count and the embarrassing break above the 1-billion level was averted (FAO 2012, 9 and 51). *The Economist* magazine celebrated this vindication of neoliberal globalization with a gleeful editorial (Economist 2012).

According to the latest FAO report, the global number of undernourished people declined from 2005 to 2014, reaching a low of 538.7 million, 7.3% of humankind ... and then rose consistently from there to reach a reported 733.4 million or 9.1% of the humanity in 2023 (FAO et al. 2024, 5–8). The traditional name of the annual report, *The State of Food Insecurity in the World*, was in 2017 revised to a more upbeat *The State of Food Security and Nutrition in the World* – though the old acronym "SOFI" is still commonly used – and the list of organizations jointly vouching for the report has been expanded to five UN agencies: the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD), the United Nations Children's Fund (UNICEF), the World Food Programme (WFP), and the World Health Organization (WHO).

Throughout this entire period, additional governmental commitments kept coming. There was the 1999 *UN Millennium Declaration* ("to halve, by the year 2015, the proportion of the world's people … who suffer from hunger"), followed in 2000 by the *Millennium Development Goals* ("halve, between 1990 and 2015, the proportion of people who suffer from hunger") (Key Indicators for Asia and the Pacific, 2009) and eventually, in 2015, followed by *Agenda 2030* (Sustainable Development Goal 2: to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture"). Commitments to end undernourishment were also made specifically in and for Africa, notably in the 2014 *Malabo Declaration* (Target III: "Ending Hunger in Africa by 2025") and in the 2015 *Africa Agenda 2063 (Aspiration 1:* envisioning "a prosperous Africa based on inclusive growth and sustainable development" with the key goal of ensuring a continent of "healthy and well-nourished citizens").

In assessing these governmental commitments and the evolution of undernourishment over time, it is essential to take a closer look at the official definition of undernourishment which the FAO newly introduced in 2012. The fine print of the annual report for that year explicates the new definition with commendable clarity:

> "undernourishment" has been defined as an extreme form of food insecurity, arising when food energy availability is inadequate to cover even minimum needs for a sedentary lifestyle.…the FAO indicator is designed to capture a clearly – and narrowly – defined concept of undernourishment, namely a state of energy deprivation lasting over a year (FAO et al. 2012, 50).

This still operative official definition has four key elements. A person is to count as undernourished at some particular time just in case this time *is part of a period of more than one year* during which the *food energy* that is *available to her* – also referred to as her *dietary energy intake* (FAO et al. 2012, 50) – is insufficient *to cover even minimum needs for a sedentary lifestyle*. Let us look more closely at these four elements of the FAO's definition. Let us unpack these four essential elements.

First, the definition focuses solely on dietary energy. But human beings do not live on calories alone. They need various proteins, vitamins, minerals, and other micronutrients to be adequately nourished, nay even to survive. Deficiencies in such nutrients are extremely widespread among poor people in less developed countries. Three such deficiencies, in particular, each cause hundreds of thousands of annual deaths, especially among children aged 0 to 59 months old. **Vitamin-A** deficiency substantially increases deaths from measles, diarrhea, and malaria, and also causes much vision impairment and blindness. **Iron** deficiency results in widespread anemia, causing maternal and perinatal deaths and deaths in young children. **Zinc** deficiency contributes substantially to deaths from diarrhea, pneumonia, and malaria in children under five. Also important are **iodine** deficiency, which impedes intellectual development and physical growth, and **essential fatty acids deficiency**, which impedes growth in children and increases their susceptability to infection.[1] By ignoring such specific nutrient deficiencies in its definition, the FAO is failing to recognize as undernourished all those hundreds of millions of people who take in sufficient energy (calories) but do not get some of the specific nutrients essential to healthy survival.

Second, the FAO definition focuses solely on dietary intake. But not all nutrients a person ingests are absorbed by her or his body. Many people in impoverished regions are infected with parasites that can consume as much as one-third of the nutrition they ingest. And others there suffer from diseases that impede the absorption of nutrients through the small intestine. By ignoring these common problems through its exclusive focus on intake, the FAO is further enlarging its undercount of the world's undernourished by failing to recognize all those whose nutrient intake is adequate even while their nutrient absorption is not.

Third, the FAO's operative definition counts a person as undernourished only if her energy intake is "inadequate to cover even minimum needs for a sedentary lifestyle." But many poor people in less developed countries do not, and cannot, indulge in such a lifestyle. The 1800 daily kilocalories that may suffice to keep an academic going do not suffice to sustain a rickshaw driver, whose income depends on transporting heavy loads on battered roads, often uphill, or a homemaker who must collect firewood, grind cereals, participate in harvesting, wash clothes in the local river, transport large jugs of water from a distant well, all while carrying her infant on her back. Heavy physical activity can increase calorie consumption by a factor of 5 to 17 (about 7-fold for activities such as jogging, cycling, and swimming), thereby tripling or quadrupling daily energy consumption. By defining undernourishment in terms of the minimum requirements of a sedentary lifestyle, the FAO is then failing to recognize as undernourished all those millions who get enough food for a sedentary lifestyle but not enough for the work they do, and must do, to sustain themselves and their families.

Fourth, the FAO counts only nutritional deficits that last for "over a year." This decision was crucial in keeping the number of undernourished from breaking above 1 billion by erasing the effect of the global food price spike in 2008 (and the similar spikes in 2011 and 2022).[2] This decision also erases from the record famine and hunger events that do not last a full year, including seasonal undernourishment, frequent during wintertime and during dry season in Africa. Every year, millions suffer life-threatening food shortages when the lean season (June to August) combines with severe poverty to quadruple the number of food insecure people in West and Central Africa (WFP 2024b, cf. WFP 2024c). The FAO's official justification for its decision is remarkable:

> The reference period should be long enough for the consequences of low food intake to be detrimental to health. Although there is no doubt that temporary food shortage may be stressful, the FAO indicator is based on a full year (FAO et al. 2012, 50).

[1] These five common deficiencies are thoroughly discussed in Caulfield et al. (2006) and Kiani et al. (2022).
[2] See world food price data at https://www.fao.org/worldfoodsituation/foodpricesindex/en/

The implied claim that hunger is detrimental to health only if it lasts for more than a year is blatantly incorrect. We know from the historical record of famines and hunger strikes that, with sufficient clean drinking water, human beings can survive without food for about 45–60 days at a low activity level. Even when they can get a little food, people in famines often succumb in well under a year – many historical famines have been shorter and still killed tens of thousands of people. Moreover, there are hundreds of studies documenting the long-term health effects of even brief periods of undernourishment especially on children. Such temporary food shortage often permanently impedes mental and physical development, causing lifelong deficits in height, health, and mental functioning (including stunting and wasting). In fact, there are documented health deficits in children whose mothers suffered hunger a generation before (Bhalotra et al. 2011). By recognizing only undernourishment lasting for over a year, the FAO is failing to recognize all those millions of people whose health is ruined by shorter periods of inadequate nutrition. These people constitute a substantial proportion of the 9 million human beings (including 3 million children) who die annually from hunger (WFP 2021, WFP 2024a) – even though they die from inadequate nutrition and nothing else. Many die in under a year after losing their access to adequate food as a result of some adverse change in their circumstances, due to famine, war, or natural disaster, for example, or due to an emergency affecting their household or community, such as disease or accident, loss of employment, a failed harvest, or soaring prices of other necessities such as fuel and transport. Yet, all these people are excluded from the FAO's undernourishment count because they did not manage to survive their nutritional deprivation for a full year.

In response to criticism such as the above (Lappé et al. 2013, Pogge 2016), the FAO has recently been providing data also on two broader indicators of undernourishment. One of these broader indicators is food insecurity, further differentiated into moderate and severe. The FAO reports that, from 2014 to 2023, the number of people suffering from moderate or severe food insecurity had risen by over 50% worldwide (from 1,544 to 2,325 million) and in Africa even by over 65% (from 512 to 847 million) (FAO et al. 2022, 26, and FAO et al. 2024, 15). Like the above-cited data on chronic undernourishment, these figures show that, while the global food situation had improved in the run-up to 2015, the target date of the Millennium Development Goals, it clearly has very seriously deteriorated since that time, starting long before the COVID-19 pandemic and Russia's invasion of Ukraine. One important driver of this deterioration is climate change which, caused by enormous greenhouse gas emissions in the global North, has its most devastating effects in the global South – especially in Africa, where it brings droughts, desertification, and extreme temperatures that make most agricultural labor biologically impossible. In addition, many politicians felt they had done a good deed by adopting their Agenda 2030 and hence could postpone well into the 2020s any serious efforts toward realizing the Sustainable Development Goals formulated therein.

The other, even broader indicator of undernourishment the FAO has introduced is the ability to afford a healthy diet. Converted at purchasing power parities into so-called international dollars (which are meant to reflect the purchasing power that a U.S. dollar has in the United States), the cost of such a diet varies regionally depending on how high or low the prices of essential foodstuffs are relative to prices in general. For the year 2022, the FAO reports that the global average cost of a healthy diet was 3.96 international dollars per person per day – with the highest cost found in the Caribbean (5.16) and South America (4.29), and the lowest cost in Northern Europe (3.28) and North America (2.96) (FAO et al. 2024, 25).

Anyone familiar with food prices in North America will understand that purchasing a healthy diet in the United States for under USD 3 per person per day is difficult, if not impossible, considering that getting healthy food at the lowest prices often requires time and money for travel. In the year of the latest FAO assessment, 2022, the U.S. Department of Agriculture calculated the weekly cost of its cheapest healthy diet, the Thrifty Food Plan, at USD 219.60 per week for a reference family of four.[3] This comes to USD 7.84 per person per day, 165% more than the cost of a healthy diet assessed by the FAO.

Region	2017	2018	2019	2020	▼ 2021
Madagascar	97.1	97.3	97.1	97.8	97.8
Malawi	94.5	94.9	95.4	95.8	95.9
Burundi	95.8	95.0	95.0	95.7	95.9
Central African Rep.	94.6	94.5	94.4	94.5	94.6
Nigeria	90.2	91.1	91.8	93.1	93.5
Liberia	91.8	91.6	91.4	91.6	92.8
Haiti	84.7	84.7	86.9	88.9	92.6
Mozambique	91.2	90.6	90.8	91.9	92.5
Niger	92.9	91.4	90.4	90.9	92.0
Congo	88.6	90.0	90.0	90.8	91.5
Zambia	88.5	88.2	88.6	89.6	90.0
Guinea	88.5	89.0	88.8	88.7	89.1
Angola	81.4	82.7	83.9	86.7	88.1
Lesotho	83.2	83.4	83.8	87.0	87.9
Dem. Rep. Congo	94.2	91.0	88.9	87.1	85.5
Sudan	88.4	90.9	93.6	94.1	85.4
Tanzania	85.9	85.5	84.8	85.1	85.0
Guinea-Bissau	84.4	84.9	82.9	83.9	84.6
Ethiopia	85.8	84.1	83.4	83.3	83.8
Sierra Leone	84.2	84.2	81.3	82.5	83.5
Chad	82.7	80.9	79.3	82.4	83.1
Pakistan	81.0	79.8	81.4	83.5	82.8
Benin	90.6	86.8	82.4	82.1	82.6
Rwanda	87.0	83.9	81.9	84.6	82.0
Uganda	84.5	83.4	82.9	82.6	81.7
Sao Tome and Principe	76.6	76.3	76.7	77.3	78.2
Burkina Faso	83.0	79.7	76.8	77.6	77.6
Ghana	80.0	78.6	77.0	78.1	77.4
Nepal	80.3	77.2	75.0	77.1	76.4
India	78.8	73.2	71.4	76.2	74.1
Philippines	70.1	70.0	68.4	74.2	74.0
Laos	75.3	73.6	72.7	74.7	74.0
Kenya	77.4	74.5	73.7	74.5	74.0
eSwatini	77.1	75.8	75.0	75.3	73.8
Myanmar	71.0	66.6	63.3	62.3	73.8
Côte d'Ivoire	77.7	73.4	72.0	72.8	72.9
Gambia	72.6	70.8	69.6	71.8	72.2
Mali	77.3	74.5	69.7	71.4	72.0
Indonesia	72.8	71.0	69.5	70.2	70.8
South Africa	65.3	64.9	65.1	67.0	66.7
Bangladesh	75.3	72.5	70.8	68.7	66.1
Djibouti	65.8	66.4	65.2	66.7	65.3
Mongolia	58.5	55.2	55.0	60.0	64.1
Fiji	44.9	45.8	52.9	56.8	63.7
Jamaica	57.9	57.1	57.9	64.0	62.6
Mauritania	61.7	61.1	59.7	60.9	62.4
Egypt	67.4	70.1	67.2	63.2	61.6
Cameroon	59.2	58.8	58.7	59.8	60.5
Botswana	63.2	60.8	59.8	63.4	60.3
Namibia	55.4	55.2	56.6	59.0	59.5
Suriname	44.5	45.0	43.9	54.3	58.6
Kyrgyzstan	56.3	47.2	45.0	55.3	58.2
Sri Lanka	56.6	52.0	48.5	54.0	55.5
Belize	50.9	50.7	49.4	57.0	53.0
Bhutan	51.2	45.5	42.3	45.7	45.2
Senegal	53.5	48.0	45.9	46.2	45.0
Honduras	48.5	48.0	46.5	49.7	44.8
Tajikistan	49.8	44.6	44.0	46.8	44.3
Armenia	37.1	37.9	40.0	39.0	41.4
Cabo Verde	44.5	42.2	39.7	44.0	41.2

Table 1. Countries in which over 40% of the population cannot afford a healthy diet. These include a large majority of African countries (highlighted).
Source: Food Systems Dashboard 2024.

[3] https://fns-prod.azureedge.us/sites/default/files/media/file/CostofFoodJul2022Thrifty.pdf

Despite setting the cost of a healthy diet at such an unrealistically low level, the FAO found that, in 2022, 64.8% of Africans and 34.4% (2,826 million) of the world's population were undernourished by this standard (FAO et al. 2024, 29; see also Table 1). These are frightful figures, especially when the very low stipulated cost of a healthy diet is juxtaposed to the global average income which, in the same year 2022, corresponded to 62 international dollars per person per day.[4] We have created a world in which nearly 3 billion human beings cannot afford a healthy diet because they are reduced to well under one-tenth of the global average income.

Over the last two centuries, humanity has achieved enormous gains in its scientific, technological, economic, and administrative capacities and, partly as a result, has become highly interconnected. This makes it possible greatly to reduce the vulnerability of human beings to local conditions. If certain foodstuffs are scarce in a certain area, for example, they can easily be brought there. In fact, many countries – including Japan, Singapore, and Norway – routinely import much of their food, not merely in crisis times or during the off-season. Scandinavians eat plenty of fresh fruits and vegetables year-round, even during their long and dark winter months. They never lack access to a healthy diet because the buying power of their incomes makes it lucrative for relevant firms to serve them with a steady supply of high-quality foods.

One important reason for the dire global food situation is then the global distribution of income and wealth. People lack food because they cannot afford to buy it. Of many places where undernourishment is rampant it is true that, if the people there had more money, then food would be produced for, and delivered to, those places. This insight draws our attention to the existing, enormously unequal distribution of income and wealth in the world. This inequality has rapidly emerged in the colonial and early post-colonial period and is now deeply entrenched as those at the top of this distribution have both the incentive and the power to defend their lopsided shares. In 2022, the richest 1% of the human population owned 44.5% of global private wealth while the poorest 50% owned less than 1% (UBS 2023, 121). Mostly through their influence on powerful national governments, that of the United States first and foremost, the rich can and do ensure that the world economy is structured so as to preserve and enlarge their advantage.

To be sure, the global income and wealth distribution is not the only relevant factor. There are hard-to-reach areas with small populations that are expensive to supply and therefore might suffer undernourishment even if they could afford a healthy diet at typical prices. And then there are disruptions – such as wars, civil wars, economic sanctions, natural disasters, pandemics, economic crises – which may trigger severe local food shortages. But even with such disruptions, money matters. When an earthquake disrupts transportation in a rich country, such as Japan, people are quickly supplied by helicopter, whereas in poor areas, such as Syria or Sudan, people often wait in vein for relief. And when disruptions generate local scarcity, then the more affluent tend to outbid and outmaneuvre the poor to get preferential access to whatever is available.

What can be done to improve the global food situation and, in particular, to bring down the exceptionally high incidence of undernourishment in Africa? The foregoing remarks suggest three broad approaches to the problem. One involves the reduction of poverty through economic growth in impoverished regions and especially through faster-acting and ecologically less harmful reductions of economic inequality, with special emphasis on the poorest households, including their children. A second approach involves improvements in production and delivery with the aim of raising the quality and lowering the prices of the assortment of foodstuffs available for purchase. Important components of this second approach are reduction

[4] In 2022, the global average income in terms of purchasing power was reported to be equivalent to USD 22,555 per person per year, or USD 61.79 per person per day (www.theglobaleconomy.com/rankings/gdp_per_capita_ppp).

of food waste at all stages, good long-term planning to maintain soil quality and delivery infrastructure, and aligning local production and consumption of foodstuffs so as to hold down transportation costs. The third approach involves anticipating, preventing, mitigating, and adapting to disruptions which, in this era of rapid climate change, are becoming ever more frequent and severe. The present volume explores ideas in these directions, with special emphasis on the African continent whose people unjustifiably suffer a grossly disproportional share of global nutrient deficiencies.

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Research Paper

The Changing Dynamics of Agricultural Land Use in Kenya: Legal responses to address the threat of food insecurity from land fragmentation

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Abstract: Land fragmentation is a critical issue in Kenya, posing a major threat to food security in the country. This study investigates the impact of land fragmentation on food security, with a focus on changes in agricultural land use. Using a mixed-methods approach that uses qualitative and quantitative data from desktop research, the findings reveal that land fragmentation leads to a rapid decline in arable land without the corresponding technologies to improve productivity. Cultural practices, shifting agricultural habits, and changing demographics drive land fragmentation, resulting in reduced agricultural productivity, limited credit access, and higher transaction costs, all of which adversely affect food security in Kenya. The study also emphasizes the significance of land tenure security, particularly for smallholder farmers who own fragmented land. Insecure land tenure hinders investment, credit access, and long-term agricultural planning. The paper concludes by recommending policy interventions such as land consolidation programs, leasing and collective farming, as well as property tax to address the issue of land fragmentation and enhance food security.

Keywords:
1. Land use change
2. Agriculture
3. Land fragmentation
4. Land leasing
5. Contract agriculture

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1. Introduction

According to the Kenya National Bureau of Statistics (KNBS, 2019), Kenya's population is expected to grow at an annual rate of 1.5% over a twenty-five-year period starting from 2020. This population growth drives increased demand for land, leading to fragmentation due to subdivision and land use changes, particularly on agriculturally productive lands. The process of inheritance further accelerates sub-division as beneficiaries of deceased landowners seek their share of the land. As plots become smaller, the type of farming conducted on them has shifted towards small-scale subsistence farming. This has led to difficulties in adopting modern technologies, accessing credit, and long-term production planning for smallholder farmers, thus limiting their potential to increase yields. The situation is further exacerbated by rural-urban migration, where younger demographics opt for urban opportunities over rural ones, leading to labor shortages in the agricultural sector. This reduced labor availability has resulted in decreased agricultural productivity, leaving land fallow in the absence of alternative labor sources.

Land tenure insecurity also plays a significant role in undermining food security. The prevailing cultural practices in many Kenyan communities, such as favoring male heirs over female heirs in asset inheritance, deprives women of the benefits of land ownership, despite their larger role in the agricultural labor force (NLC & FAO, 2021). As a consequence, women face difficulties accessing credit, which often requires land as collateral, since they lack title documents in their names. The overall succession process in the country is not well understood, lengthy, and cumbersome, often leading to incomplete land distribution and a lack of secure tenure. To address these issues and their socioeconomic impacts, this paper suggests implementing policy interventions aimed at combating land fragmentation. If adopted and executed, these interventions can improve agricultural productivity, reduce transaction costs, and ultimately contribute to improved food security in Kenya.

2. Drivers of Agricultural Land Fragmentation

Agricultural land use disruption is characterized by the adoption of new uses for land brought on by pressures from population growth, urbanization, inheritance, and climate change. These changes impact the security of tenure and the ability of landowners to realize the agricultural potential of the land.

2.1. Urbanization

According to the Kenya National Bureau of Statistics, 27.51% of the population live in urban areas with an annual growth rate of 0.48% (KNBS, 2021). Devolution, following the promulgation of the Constitution of Kenya (Government of Kenya (GoK), 2010), heralded the growth of at least 47 new urban centers which attracted rural-urban migrants in search of white-collar employment and investments. The net effect of migration is the increased demand for land for settlement which had previously been used for agriculture. Ideally, urban growth should follow controlled land use planning. In reality, however, rapid urbanization has coincided with unchecked expansion and disregarded zoning regulations. In Nakuru, for example, population growth has caused the town to rapidly expand, forcing land use planners to revise master plans to accommodate the disruption with the resultant effect of reducing land under vegetation in favor of residential and commercial development (Annan et al., 2022). At the core of urban expansion is the subdivision of land in satellite towns, which were hitherto sparsely populated farmlands. As demand for land to supply urban amenities increases property values, landowners have been dissuaded from pursuing the relatively less lucrative but all-important agricultural work (Auya et al., 2022). Even in peri-urban areas used for smallholder farming, there is a notable deviation from agriculture as demand grows for settlement and commercial spaces, threatening urban and peri-urban agriculture (Wilkomm et al., 2021).

Urbanization significantly affects food availability, affordability, and supply. As rural-urban migration increases and younger populations opt for urban, white-collar jobs, labor availability for crucial food production declines. This demographic shift leaves agricultural land vacant and underutilized. Non-farming urban dwellers become net food buyers (Szabo, 2015), and their access to adequate and high-quality food depends on personal income and availability. Rising food prices disproportionately affect poor, urban households, leading to fewer meals or sacrificing other expenses to buy food. The changing lifestyle of the growing middle class is also driving an increase in the consumption of processed foods high in sugar and sodium or unhygienically prepared street food, leading to a rise in lifestyle diseases, foodborne illnesses, and malnutrition (Matuschke, 2009; Mensah et al., 2002).

2.2. Succession

Land is an emotive subject in Kenya, as it is not only a source of income but also considered to be a valuable asset. It is a common desire to own land for stature, investment, and to secure current and future living conditions (Grigg, 1980 as cited in NLC & FAO, 2021). Inheritance, a prominent means of acquiring farmland, subdivides land among the heirs of a family. Traditionally, many Sub-Saharan African societies followed patrilineal succession practices where land was divided among male heirs of the household (Demetriou, 2014). However, the Constitution of 2010 ended this discriminatory practice in Kenya by allowing equal rights between male and female heirs, thus intensifying fragmentation to allow distribution to the additional beneficiaries.

A study of 13 counties by the NLC & FAO (2021) revealed that 65.4% of the respondents acquired their land through inheritance. Moreover, the majority of inherited lands measured under two acres (NLC & FAO, 2021). These relatively small parcels of land are mostly suitable for subsistence farming rather than the profitable cash crop farming. Cash crops require large tracts of land for economic viability and are difficult to cultivate on limited plots (Mwesigye & Barungi, 2021). As a result, the prevailing pattern of land inheritance and subdivision can hinder the cultivation of cash crops, which have the potential to boost income and economic growth. The fragmentation of land into smaller pieces limits the scale of agricultural operations, making it difficult for farmers to benefit from economies of scale and modern agricultural technologies (Bentley, 1987). Furthermore, the practice of dividing land equally among heirs often leads to land parcels that are too small to be effectively managed or cultivated profitably. Consequently, this situation perpetuates subsistence farming and impedes the transformation of the agricultural sector into a more commercially viable and productive enterprise. Addressing land fragmentation and its associated challenges is essential to unlock the full potential of agriculture and improve food security and livelihoods in Kenya.

2.3 Climate Change

Kenyan farmers rely largely on the natural weather for their agriculture. Planting seasons are planned based on expected long and short rains that traditionally arrived in March – May and October - December, respectively (Kenya Meteorological Department, 2020). Climate change has led to unpredictable weather patterns, including five consecutive failed rain seasons, that have significantly impacted food production and hindered the country’s food security. (IGAD Climate Prediction and Applications Centre, 2023). Increasingly adverse weather conditions as a result of climate change and climate variability through sustained droughts and floods have compromised the chemical integrity of soil and inhibited the ability of natural vegetation to regenerate, causing severe degradation of the land. Land degradation is the multifaceted and gradual decline in the physical, biological, and chemical aspects of both soil and vegetation. It crucially affects the overall economic productivity of terrestrial ecosystems, soils, vegetation, living organisms, and associated ecological, biogeochemical, and hydrological processes.

(Reynolds, 2001 as cited in Waswa, 2012). In the face of these challenges, farmers are urged to adopt technologies that enhance crop resilience. However, poverty among smallholder farmers hinders their ability to afford high quality seeds, forcing them to reuse seeds with low yields from previous harvests, perpetuating the cycle of low productivity and profits(Annan et al., 2022). Furthermore, due to the urgency to improve yields, planting seasons are being shortened, leaving little time for soil to regenerate and inadvertently exacerbating the problem.

The result of drought conditions experienced in the country is a systemic reduction in arable land. Deforestation is rampant as alternative land is sought for subsistence agriculture and settlement. The Mau Forest, for example, has experienced significant land cover change due to population growth demanding land for settlement and subsistence agriculture. The encroachment has led to drastic and considerable land fragmentation, deforestation of important water towers, and as a result, further degradation of fertile topsoil and dwindling water resources (Olang & Musula, 2011). Undoubtedly, overexploitation of forest resources is one of the main drivers of climate change threatening the livelihoods of forest-dependent people who cannot adequately adapt to changing conditions (Di Falco, 2014).

3. Impact of Land Tenure Insecurity on Food Security

Land tenure encompasses the rights and responsibilities tied to land ownership, usage, transfer, and succession (La Croix, 2002). Typically, land tenure security is associated with having an official title issued by the government. It involves the extent of a landowner's rights to control, manage, utilize, and dispose of the property (La Croix, 2002; FAO, 2002; Economic Commission for Africa, 2004). However, this perspective overlooks unregistered land use rights, leading to situations where women are disadvantaged in communities that favor male land registration. Widows are often disinherited by in-laws when male landowners pass away. Nonetheless, attempting formal succession is challenging, expensive, and time-consuming resulting in informal ownership structures.

Land fragmentation threatens land tenure security, especially where rights are not formally recognized (Cholo et al., 2019). While the Constitution of Kenya recognizes equal rights between men and women to own property, historical and cultural norms are still prominently upheld in most Kenyan communities. In such instances, it is common to find that land is subdivided among male heirs while women are relegated to farmhands who produce enough food for household consumption. Decision making on the sale, leasing, and profits from farm produce is often entrusted to the men while women merely determine which subsistence crops to plant (Mwesigye & Barungi, 2021).

As society evolves to become more consumerist, there is a preference for private land ownership, leading to the conversion and disposal of community lands to private owners. The subdivision of formerly communal lands to smaller parcels for disposal to individuals intensifies fragmentation and loss of arable land to boundaries. Furthermore, it dispossesses those who cannot afford to register official titles in their favor people who would otherwise have been able to eke out a living from the utilization of communal land. The lack of titles impedes access to credit since landowners do not have titles against which credit can be collateralized. The size of the land also affects the degree of credit that can be afforded to a farmer, as the value of the land must be commensurate to the amount borrowed, which in turn impedes on farmers' capacity to deploy modern farming techniques that would increase the productivity of the small plots on which they farm.

4. Policy Recommendations to Address Land Fragmentation

The Constitution has empowered parliament to enact legislation prescribing minimum and maximum acreage of land with respect to private property, with the objective to ensure sustainable use and equitable access to land. This forms the basis on which county governments formulate development plans to regulate land use (GoK, 2019). Land control boards established under the Land Control Act exercise oversight over the use of agricultural land to ensure that it is effectively utilized. Unfortunately, the complacency of government agencies in failing to enact critical legislation and failure to implement existing laws threatens to worsen land fragmentation. (Mbuvi et al., 2022). To discourage fragmentation, especially where subdivision is done for speculative purposes, the proposed Rating Bill can be used to impose property taxes on idle land.

4.1. Restriction on Minimum Acreage

Proposals for minimum and maximum private land sizes have been explored in Kenya before. The National Land Policy of 2009, with consideration for population growth and increasing demand for land for agriculture and settlement, proposed the development of a system to determine minimum acreage and ensure all subdivided properties conformed to set minimums (GoK, 2009). A 2015 bill known as the Minimum and Maximum Land Holding Acreage Bill was presented in Parliament for debate, but it lapsed before it would be passed into law. The Bill established sub-county land control committees which would conduct scientific studies to determine the minimum and maximum land sizes for various uses and carry out periodic revisions of minimum and maximum land sizes (GoK, 2015). The debate on landholding restrictions can generate emotive and hard-lined positions from both policymakers and landowners. Nonetheless, it remains one of the greatest tools to curtail land fragmentation. A viable alternative would be to move the debate to counties where land sizes are infused with local zoning laws. At this decentralized level, the county governments are better positioned to effectively respond to their unique circumstances.

4.2. Taxing Idle Lands

Land is a highly profitable asset and is perceived as a secure investment with a continuous appreciation in value. The demand from investors has led landowners and land dealing companies to subdivide land into smaller parcels to maximize profits. However, this land subdivision often results in speculative purchases, where land remains undeveloped. This phenomenon of land speculation is influenced by inadequate public policy planning, linked to planned or ongoing infrastructural development in a region (Kinuthia et al., 2021). Land speculation has negative consequences, including reducing available land for use as it is often split in anticipation of price increases (GoK, 1959). Furthermore, it leads to underutilization since the land may not be put to productive use before resale. In areas like Kajiado, where pastoralism has been a traditional way of life and an economic backbone for the Maasai people, the subdivision of land for speculation severely diminishes available grazing land (Rozen, 2016). A straightforward measure to counteract land speculation and encourage development is to implement property taxes on vacant land (Amirtahmasebi, Orloff & Wahba (n.d)). Currently, the Rating Act has been unsuccessful in preventing land fragmentation, as rates are determined by market valuation rather than land use. The proposed National Rating Bill should be revised to explicitly introduce deterrent rates on idle land, aiming to effectively address the issue of land fragmentation for speculative purposes.

Inheritance causes land subdivision to distribute assets among beneficiaries, but this does not guarantee that they will develop the parcels they inherit. Often, new landowners may live elsewhere without utilizing their land for agriculture, posing a risk to food security due to under exploitation (Waswa, 2012). Land control boards should be held accountable when they permit dealings in agricultural land that do not foster agricultural productivity on freehold land. On the other hand, government leases are subject to conditions set by the landlord. All leases granted by the government impose a condition to develop the land within the stipulated period. If these conditions are not met, the tenant risks property forfeiture or a denial of renewal of the lease on expiration.

4.3 Farm Enterprise Restructuring

Although there is opposition to land fragmentation, some argue in its favor, suggesting benefits such as crop diversification, optimized agro-ecological zones, and reduced risk of disasters and pests for smallholder farmers (Iheke, 2016). More pressing, however, is Kenya's persistent food production deficit that relies on imports to meet the country's needs (Mohamed, 2021). Developing agriculture for commercial purposes may be a more sustainable approach. Consolidation could provide a pathway towards creating bigger land plots and promoting large-scale commercial agriculture. Land consolidation provides a remedy to fragmentation by exchanging scattered plots for larger ones (Melmed-Sanjak, 1998 as cited in Hristov 2009) and offers numerous advantages over fragmentation, including reduced production costs due to minimized travel between parcels (NLC and FAO, 2021), improved access to essential infrastructure like roads and irrigation channels (Hristov, 2009), increased crop options, including economically viable cash crops suitable for larger plots, and enhanced credit access due to higher land market values. Despite this, consolidation is socially and financially demanding, requiring significant time and expertise to implement.

Where consolidation may not be feasible, land leasing can address the issue of fragmented agricultural land. Encouraging landowners of scattered plots to lease their land to investors immediately corrects the engrained practice of subdividing inherited lands while simultaneously enabling large-scale production. Land lease can be a cost-effective alternative to consolidation, employing collaboration among neighboring smallholder farmers while making use of vacant and underutilized land.

Smallholder farmers can address the challenges of land fragmentation through collaborative efforts such as collective contract farming. Contract farming involves an agreement between a farmer and a buyer to produce and purchase products at a prearranged price, with the buyer often providing technical support and agricultural inputs (Minot, 2012; FAO, 2023) Through collective contract farming, neighboring smallholder farmers can pool their resources and negotiate agreements with investors for food production at agreed-upon prices. This collaborative approach prevents individual farmers from being disadvantaged in negotiations and empowers them to speak with a unified voice, leading to better results. Similar to land leasing, collective contract farming efficiently uses fragmented land while fostering rural development. In addition, it can reduce the need for lengthy and costly succession procedures by promoting collaborative farming among beneficiaries.

5. Conclusion

Food security is a major concern in Kenya due to the reliance on rain-fed agriculture, which has become unpredictable and insufficient. Failed rain seasons and extended droughts caused by climate change lead to land degradation and forest encroachment, further exacerbating the situation. The increasing population exerts pressure to expand settlements into agricultural areas, resulting in the loss of productive land due to urbanization and land subdivision caused by inheritance.

To address land fragmentation, existing policies and legislation should be strengthened, and institutions responsible for preserving agricultural land should be held accountable. Consolidating fragmented land into larger tracts can support large-scale commercial agriculture to meet domestic food needs and facilitate surpluses for export. In cases where land consolidation is not feasible, neighboring fragmented plot owners can consolidate their land and encourage commercial crop choices by leasing it to investors. Additionally, neighboring smallholder farmers can also utilize collective contract farming to enhance rural livelihoods by entering into farming contracts with buyers for prearranged prices.

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Better Soils for Resilient Agricultural Production

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Abstract: Agriculture plays a pivotal role in improving food security and reducing poverty in Africa, as well as in promoting climate change mitigation and adaptation and general progress on the Sustainable Development Goals (SDGs). In Sub-Saharan Africa (SSA), the agricultural sector employs 70% of the population and is estimated to contribute roughly 15% to GDP. But changing climate conditions and poor agricultural practices lead to soil degradation of up to 65% of agricultural lands in SSA, threatening food security. The "betterSoil" concept is a holistic and systemic approach that stresses the whole, considers essential regional aspects to link economic prosperity and sustainable agricultural practices, and addresses climate change. Its four simple principles – soil management, compost, biochar, and agroforestry – can unlock the potential of soils to restore soil organic matter, to protect soil fertility and biodiversity, and to sequester CO2 for the future build-up of humus in agricultural soils. Better soils can promote economic growth and development, especially in low-income countries hit hardest by climate change. Its four principles support the introduction of climate-positive practices that can be implemented anywhere. To harvest the benefits of large-scale soil improvement, farmers, governments, the African Union, individuals, the private sector, and practitioners must work together to bring theory on better soils into practice.

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1. Agriculture
2. Food security
3. Poverty
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5. Sustainability

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1. Introduction

Climate change has significant global economic, societal, and environmental impacts, including extreme weather conditions (floods and droughts), landslides, loss of soil organic matter, soil degradation, and desertification. Studies predict that, without substantial and extensive mitigation actions, negative impacts will dramatically worsen by the end of this century, with the mean temperature rising by 4.1 to 4.8°C (IPCC, 2022, pp. 22 & 23). In the Paris Agreement, governments around the world expressed their goal of keeping the global rise in mean temperature well below +2°C (pursuing efforts to stay below +1.5°C) compared to preindustrial levels (Paris Agreement, 2015). Also signed in 2015, the Sustainable Development Goals (SDGs), in line with their predecessors, the Millennium Development Goals, seek to improve social and economic conditions by reducing hunger and poverty. While also pursuing environmental goals (SDGs 13, 14 and 15), they contain a huge conflict of goals in our current techno-economic system. For a better world in which the SDGs are achieved, a combination of two measures seems to be necessary. First, a fairer distribution of global value creation and income between the poorest 40% and the richest 10%. To fulfill the SDGs solely through such a fairer distribution is possible but not realistic because it would involve a massive cut of wellbeing of today's richest 10%. Hence the second measure of economic growth and wealth creation must also be pursued – through international cooperation that avoids destroying the environment. Probably, this automatically leads to a dematerialization of what we call wealth today. Under current conditions, rising prosperity is associated with increased resource consumption and CO_2 emissions, and with the exploitation of certain low-income groups.

This is why the SDGs and the Paris climate goals are unlikely to be achieved. To fix the issue, we need a paradigm shift toward aligning increasing prosperity with social progress and ecological protection and restoration. In economic terms, such solutions internalize environmental and social externalities of the economy's operation. Especially in the agricultural sector, such efforts are crucial because they promise large gains for most SDGs. The reason is that most people in poor (e.g., SSA) countries work in the agricultural sector. This sector also produces roughly 25% of greenhouse gases while destroying biodiversity and ecosystems. Agriculture is closely connected to the water cycle and nutrient cycles like nitrogen, carbon, and phosphorus – all of which are out of balance. As conditions in this sector improve, women benefit disproportionally as they are overrepresented in agriculture in poor countries. This, in turn, will improve the education of their children. As this article describes, measures to improve the agricultural sector would also lead to improved soil health, with gains for 14 of the 17 SDGs.

Agriculture, forestry, and other land use account for 23% of all global CO_2 equivalent emissions (including CO_2, methane, and N_2O) (IPCC, 2021, p. 188), for 70% of freshwater use (Nhemachena et al., 2020, p. 3), and for 70% of pollution in underground water and aquatic ecosystems (FAO, 2017). Agriculture is also a major cause of deforestation and accelerates soil degradation in agricultural areas, with an annual nutrient loss in soils of about 30 to 60 kg/ha. Over the past 50 years, greenhouse gas (GHG) emissions have doubled in forestry, agriculture, and fisheries and are predicted to increase by up to 30% by 2050 if no effective measures are taken to reduce emissions (Sietz & Van Dijk, 2015, pp. 131 & 139).

At the same time, climate change hurts the agricultural sector and the food production system globally, especially in Africa, and possibly at a faster rate than elsewhere. The climate system affects the survival and reproduction of plants and animals due to rising temperatures, longer dry periods, and more-erratic rainfall. This strongly suggests that climate change endangers resilience and the productivity of agricultural and food systems.

In addition to the increasingly difficult conditions caused by climate change, unsustainable agricultural practices negatively affect soil quality. African agricultural soils are degrading due to erosion, loss of organic carbon, nutrient deficiencies, poor soil structure, and decreased water-holding and transmission capacities. Studies have estimated that in Africa up to 40% of soil is degraded, but more recent studies give higher estimates of up to 65% (Zingore et al., 2015, p. 2; Kihara et al., 2020, pp. 2, 7, & 9).

As a result, gas and nutrient cycles are disturbed and destabilized. Consequently, soil health indicators such as soil fertility, carbon content, biodiversity, water retention capacity, and pollutant degradation decrease. Maintaining and improving soil quality is necessary to meet the needs of future generations in Africa (Nde et al., 2023). This affects 46% of land area and creates costs estimated at US$9.3 billion annually (Nde et al., 2023, p. 76).

As a result of soil degradation, increased desertification, and reduced food production, water quality, natural land resilience and soil fertility decline. Poverty increases and livelihoods are lost, which in turn leads to migration. Soil degradation and desertification are among the most important factors threatening agricultural productivity and resilience, posing a serious threat to nutrition and food security, worldwide and especially in Africa. Under unsustainable agricultural practices, aggravated by climate change, soils cannot adequately fulfill their many ecosystem services to societies. Soil degradation is the primary biophysical barrier to agricultural production in Africa.

Especially bad is the negative impact of soil degradation on smallholder farms in poor regions with low *per capita* food production and low resilience to climate change (Entz et al., 2022, pp. 1 & 2). SSA, whose population will treble by 2100 (Ezeh et al., 2020), already has the greatest poverty concentration (Nde et al., 2023). Of all the people below the global poverty line, 80% live in rural areas, dependent on agriculture for their food security and livelihoods (Nde et al., 2023).

In many countries, the agricultural sector is an economic backbone, especially for poor communities; it generates 15.8% of GDP in SSA (Nde et al., 2023). Adverse agricultural practices have led to disturbances in the soil system causing soil degradation and a loss of US$7.3 billion worth of goods and services in 2015, which is anticipated to increase to US$9.5 billion by 2050. To meet food demand, agricultural production must increase by almost 70% by 2050 (Nde et al., 2023, pp. 76 & 77).

Ultimately, worsening poverty and loss of livelihoods force people to migrate to find alternative sources to support (Dimkpa et al., 2023). For farmers such sources are areas they can cultivate, but such are typically already scarce where they seek refuge. As this introduction has shown, urgent and bold action is necessary. Soil plays a pivotal role in tackling many of the problems touched upon: climate and biodiversity protection as well as promoting the SDGs.

2. Potential solutions

As described above, the current agricultural system strongly contributes to climate change. However, introducing sustainable agriculture practices has tremendous potential to improve living conditions, to maintain a stable climate and healthy ecosystems. All humans depend on agriculture for food, and many depend economically on the (often meagre) incomes they generate from food production. Cooperation to restore agricultural land and its surrounding ecosystems should no longer remain in the niche of development cooperation. It needs to become a focus area for global international cooperation beyond Official Development Assistance, especially across continents. Europe and Africa – neighbors – should lead the way.

To feed the growing human population, especially in SSA, food production must more than double by 2050. Under relatively stable climatic conditions, agriculture in SSA can continue to develop. The detrimental effects of a changing climate and soil degradation can be reversed by implementing innovative and sustainable agricultural practices. The agenda 2063 for “a prosperous Africa based on inclusive growth and sustainable development” tries to invest in modern agriculture for higher agricultural productivity with the Comprehensive African Agricultural Development Program meant to help African nations reduce hunger and poverty.

In this context, the African Union is supporting initiatives to build resilience of African communities by combating land degradation, desertification, biodiversity loss and climate change (Sacande et al., 2021).

By increasing soil fertility toward promoting food quality, water holding capacity to fight desertification, and biodiversity, soils can also be made to act as sinks to capture and bind greenhouse gases. Combined with indigenous knowledge and sustainable land management, innovative agricultural practices can allow farmers to profit from these practices (Dimkpa et al., 2023) – rather than have certain innovative measures imposed on them.

2.1. Better soils are humus-rich soils

Healthy soils are rich in humus. Sturdy, productive, and alive, they contain many living creatures. Healthy, humus-rich soils contain a lot of soil organic matter, dead and alive. As carbon is a composite of all organic matter and living organisms, enriching soils with carbon is vital for soil fertility. To determine soil health and fertility, humus and soil organic matter are good indicators. Approximately 2,500 Gigatons of soil organic carbon (SOC) are bound in humus globally (Beillouin et al., 2023, p. 4; Dunst, 2011)**.** This is more than three times the amount of atmospheric carbon dioxide and five times what is bound in plant biomass. Such humus-rich soils store carbon for hundreds of years – often even longer. Though millions of hectares of valuable soil have been degraded due to improper or excessive use or lost due to rising temperatures and subsequent desertification, this trend can be reversed, and soils be made fertile again. By actively building up humus, our current farming practices can be altered (Lal et al., 2018; IPCC, 2019).

There are benefits of soil humus build-up in different categories, e.g., soil biodiversity, water absorption capacity, nutrient storage capacity, filtering and buffering effects, saturation, carbon sequestration, soil build-up, plant protection, farming for high-quality food, food and the economy as described in Table 1 (Dunst, 2011; Smith et al., 2019; Solaiman et al., 2019; Meléndrez, 2020; Zhao et al., 2023).

Table 1. Categorized benefits of soil humus

Category	Description
Biodiversity	Humus is essential for the richness and diversity of the soil fauna. According to the US National Soil Health Board (van der Putten et al., 2023), applying any soil treatment that kills the soil microorganisms, including the application of minerals and chemicals, results in humus and fertility loss. Humus preserves biodiversity of/in forests, wetlands, and peatlands. By raising yields, higher soil humus content reduces the need for expanding agricultural land with adverse effects on biodiversity. Less land is needed for the same output (productivity increase).
Water absorption capacity	Humus is like a sponge. The ability of humus to absorb water from rainfall and release it when plants need it is 400 m^3/ha per 1% increase in humus This helps plants survive dry seasons and provides a better drainage system on the farm. During heavy rains, humus-rich soil can absorb up to 150 liters of water per hour.
Nutrients storage capacity	Humus greatly enhances the soil's storage capacity for nutrients. At a depth of 30 cm, 1% more humus results in an additional capacity of 2,500 kg/ha of nitrogen in the soil (Tsai & Chang, 2019)

Table 1. (Continued)

Category	Description
Filtering and buffering effect	High filtering and buffering effects of humus include filtering and purifying rainwater and groundwater. Humus provides a porous, soft, and aerobic space, like the structure of a sponge, which makes the soil better able to capture pollutants and pathogens. When humus builds up and carbon sequestration increases in the soil, the soil particles are coated with organic matter, absorb more pathogens, and substantially prevent them from being moved away by infiltration and runoff. This helps suppress the pervasion of soil-borne crop diseases.
Saturation	The saturation of the humic structure of the soil with water and nutrients allows additional rainwater to flow through to form groundwater. On dry and compressed soils with low humus content, water cannot penetrate and runs off, thus increasing the danger of flooding and topsoil erosion. Groundwater to support the ecosystem during dry periods is not formed.
Carbon sequestration	Humus formation has high carbon sequestration potential. Humus can bind 2-25 tons CO_2/ha/yr. Adding humus to the soil (humus build-up) by fertilization with 8 tons/ha/yr of compost led to an increase of 115 kg carbon/ha/yr. Applying compost at higher rates of 14 and 20 tons/ha/yr caused accumulation of carbon at rates of 558 and 1,021 kg/ha/yr, respectively. Accordingly, several soil functions, as well as overall soil health, were improved by soil carbon sequestration (Erhart et al., 2016).
Soil build-up	Humus prevents erosion by holding soil aggregates together, increasing organic matter, maintaining soil pH, and protecting soil from extreme climate.
Plant protection	Plants are healthier and more productive in soils that contain humus. By enabling plant roots, soil microbes, and soil structure to interact with one another, deeper root growth is possible, and humus increases plant health and promotes nutritional balance. Additionally, it holds oxygen, which is necessary for root development and supports the growth of root structures.
Farming for high-quality food	Grain yield (e.g., maize) can increase by 2.1% per year due to an increase in the soil organic carbon (SOC) pool by 0.5 tons of carbon/ha/yr. In Africa, an increase in the SOC pool by up to 1 ton/ha/yr can potentially increase food production by 9-12 million tons (Lal, 2006, p. 203). In Kenya, soil carbon conservation and farming through sustainable agricultural production can increase grain yield by 50 kg/ha for beans and 243 kg/ha for maize (Kapkiyai et al., 1999). In Western Nigeria, the SOC content in the topsoil layer (0-10 cm) was studied. For each 1% rise in SOC, an increase in yield was observed of 2.9 tons/ha for maize and 0.23 tons/ha for cowpea (Lal, 1981).
Economy	By contributing to safer and cheaper production in the medium and long term, humus leads to significant cost and effort reductions in protecting plants and soils from the adverse and devastating effects of climate change. Soils with humus mitigate climate change and help adapt to is by increasing resilience.

2.2. Four principles for increasing humus content and overall soil health

Humus provides multiple ecosystem services as benefits to humans and significantly paves the way for closing carbon and nitrogen cycles. Thus, humus has the potential to contribute substantially to climate change adaptation and mitigation (Lal et al., 2015).

> Programs to eradicate poverty and ensure food security can benefit from applying measures that promote neutrality of land degradation (including avoiding, reducing, and reversing land degradation) in rangelands, croplands, and forests, which contribute to combating desertification while mitigating and adapting to climate change within the framework of sustainable development (IPCC, 2019, p. 20).

The suggested 'measures' and agricultural practices mostly involve building up humus in the soil. In what follows, these practices will be introduced in the form of four principles to improve soils.

A) Compost

Compost is produced by the aerobic decomposition of organic matter. Applied on soil, compost has significant impacts on the improvement of its physicochemical properties. Various raw materials can be used as feedstocks to produce compost, such as organic waste from farms, manure in general, green manure legumes, and kitchen waste. Generally speaking, compost increases soil nutrient content and enriches soils with a wide diversity of microorganisms and fungi. This contributes to higher yield and enhances soil health. At the same time, farmers combine waste disposal to increase their own health with a cost-effective opportunity to increase their soil's health.

Applying compost is highly recommended as a common practice, especially in areas where SOC is low, and soil nutrients are subjected to leaching and gaseous losses. In low-input farming system such as SSA, compost can add more nutrients to the soil and increase the yields of the main crops (Frimpong et al., 2021, p. 2; Maselesele et al., 2021, p. 1). The continuous reduction in soil fertility in SSA causes a severe deficiency of phosphorus (P) in the soil, one of the main factors that constrain, e.g., maize production in Kenya. In this case, Orandi et al. (2021, pp. 332 & 334) observed an increase of up to 13.5% in maize height and a significantly yield increase of about 55.9% by applying phosphorus-fortified compost using rock phosphate. However, to avoid excessive usage of mineral P fertilizers, Gwandu et al. (2023, pp. 10 & 11) observed that co-amendment levels of 5% and 10% to compost and residual aluminum sulphate water treatment resulted in a reduction of P fertilizer requirements to 60-70% and 30-60%, respectively. This also helped improve crop yields and rebuild soil health in sandy soils of urban agriculture in South Africa. Here, Mohale et al. (2023, pp. 5, 6, 9, 10, & 11) conducted another study where they recommend applying at least 10-15 tons/ha of Eucalyptus wood-based compost to significantly raise the value of soil physicochemical properties governing decomposition of soil organic matter. This includes pH levels, electrical conductivity, organic and active carbon, mineralized nitrogen, plant available nutrients, bulk density, and soil texture.

In West Africa, Cardinael et al. (2022, p. 2) showed that combining compost and mineral nitrogen (N) fertilizer can increase the yield of maize from 5 to 6 tons/ha/yr. Every year, they observed a yield increase of 1 ton/ha, with SOC loss more than halved from -0.62 (without compost) to -0.27 (with compost) tons of carbon/ha/yr).This means for every ton of maize yield increase roughly one extra ton of CO_2 was stored in the soil.

In Cameroon, Tchida et al. (2022, p. 1) showed that enriching compost with biochar and mycorrhiza improved soil texture from sandy to clay-loam and soil pH of the soil from a very acidic to an alkaline situation. To support this, another study conducted by Tovihoudji et al. (2022, pp. 1 & 5) in northern Benin showed that enriching compost with 15% biochar resulted in higher (+86%) cotton seed production and significantly improved growth and yield of cotton. Overall, enriched compost combinations accelerate the activity of soil fauna and increase soil nutrients and water content, resulting in a smooth establishment of vegetation on degraded and degradation-prone soils of SSA (Tchida et al., 2022, pp. 14 & 16).

Furthermore, a study by Hawkins et al. (2023) has illustrated the massive potential of mycorrhizal fungi for storing carbon below ground. After reviewing more than 194 data sets and peer reviewed papers, the researchers estimated that plants pass between 1% and 13% of their carbon to mycorrhizal fungi. This is more than 13 billion metric tons of CO_2 and equivalent to approximately 36% of annual global fossil fuel emissions. The estimates were reached using conservative methods of quantifying carbon, so the mycorrhizal fungi may actually be storing much more carbon. In addition to the carbon sequestration capabilities of fungi, the immense benefits that fungi bestow on above- and below-ground ecosystems make it imperative that fungi and indeed fungal biodiversity be included in policies and practices aiming to support soil systems on which life depends. When farmers compost their organic agricultural waste, they breed fungi in their compost. Applied on their cultivated area they can unlock the power of compost with nutrients, microorganisms, and fungi.

B) Biochar

Biochar is a carbon-rich material produced from biomass. The organic input material is burned with very little oxygen. In SSA, biochar is slowly but increasingly being used as soil amendment and biofertilizer. Studies have shown that there is great potential and opportunities for biochar applications as soil amendment that also provides other environmental uses. Studies in Zimbabwe estimate that the country has biochar feedstocks of approximately 9.9 Mt/yr, derived mainly from manure (88%) and firewood (10%) and can yield 3.5 Mt/yr of biochar (Gwenzi et al., 2015). In Africa, biofertilization using biochar is mainly aimed at improving soil health and properties to enhance crop yields. Statistical meta-analysis studies using field trials of crop yield data in SSA show that biochar increases cereal grain yields by 0.18 to 1.00 tons/ha/yr (Dickinson et al., 2015). In their long-term study in subhumid regions in Kenya, Kätterer et al. (2019) showed over ten years that adding biochar to maize-soybean rotations increased yields and soil fertility. Specifically, this study showed the effect of biochar fertilization independently from other fertilization, seasons, and locations: seasonal yield increased on average by 1.2 tons/ha for maize and 0.4 tons/ha for soybeans (Sundberg et al., 2020). A similar study in Kenya using different biochar application rates (1, 5, and 10 tons/ha) showed that the maize grain yield (dry matter) on average increased by 1.0, 2.6, and 4.0 tons/ha, respectively, compared to control plots without biochar treatment (Kätterer et al., 2022, pp. 18 & 21).

Furthermore, these studies also demonstrated that incorporating biochar in small-holder farms in agricultural landscapes in Kenya significantly reduced their greenhouse gas emissions. In Western Zambia, characterized by acidic sandy arenosols, biochar fertilization increased maize yield by 350-450% (Obia et al., 2019). Under typical semi-arid conditions in South Africa, crop residue management in croplands resulted in cumulative carbon input ranging from 10.65 to 12.16 tons/ha, significantly enhancing grain yields (Nyambo et al., 2020, pp. 5 & 10). Furthermore, in Tamale, Ghana, farmers almost doubled (+93%) their lettuce yields by producing biochar on-site and including its application to their conventional agricultural practices (Steiner et al., 2018). The higher crop yields due to biochar fertilization, especially when incorporated with green manure (e.g., legumes), can be linked to increased N availability. A study in Benin showed that 156% more nitrogen was available on plots treated with biochar and legume green manure than on control plots (Partey et al., 2016).

More colloquially speaking, biochar is porous and has a large surface area. These characteristics enable biochar to act like a store for water, nutrients, microorganisms, and fungi, enabling them to survive under harsh conditions like droughts and heavy rainfalls. This is especially true of biochar applications in combination with compost: nutrients, microorganisms, fungi, and water are bound in a stable way to the structures biochar provides. As a result, plants can access needed input and interact with soil biology to the degree and at the time necessary.

C) Soil management

Soil management (SM) is a set of appropriate agricultural practices to protect soil performance, to make soils more fertile, to mitigate climate change, and to increase adaptation to climate extremes. This includes techniques and technologies promoting minimum soil disturbance, i.e., no or low tillage, maximum soil cover by cover crops, mulching and crop residues, crop diversification by intercropping (e.g., peanut-maize-beans), soil buffering by afforestation, or covering the soil with shrubs, grasses, and canopy of plants or trees and preventing soil fallow by crop rotation (e.g., beans-vegetables-maize) (Dunst, 2011; Ahmed et al., 2019, p. 66).

Low soil fertility and soil degradation are key results of poor and intensified farming practices and of recurrent, prolonged drought in SSA. Subsequently, such soils are characterized by a deficiency of essential nutrients. Adopting SM practices is vital for avoiding the loss of major agricultural products due to soil loss constraints. SM practices not only improve the physico-chemical properties of soil. With their pronounced evident role for biological indices such as stimulating soil fauna, they also play an important role for soil carbon sequestration and aggregation, nutrient cycles, and water use efficiency. Ultimately, the implementation of proper SM practices enhances soil health, maximizes crop yield, and ensures safety in food production. Proper SM practices pave the way toward achieving sustainability in agriculture (Ahmed et al., 2019, pp. 59, 61, & 65; Ayuke et al., 2019, pp. 1, 2, 7, & 10; Tufa et al., 2023, pp. 17 & 24).

The soil fauna is an important soil biological index and a suitable sustainability bioindicator of conservation measures to combat soil degradation in SSA (Danra et al., 2021, pp. 161, 163, & 175). It was shown that the development (e.g., higher abundance levels) of soil fauna indicates the efficiency of SM practices in restoring degraded soils and maintaining soil fertility. In this regard, Nde et al. (2023, p. 75) substituted mineral NPK (Nitrogen, Phosphorus, Potassium) fertilizers with mulches that can be prepared in simple ways and are easily accessible by farmers. As a result, the soil fauna was promoted with a positive impact on the soil structure and the microclimate. With dead organic matter added by mulching, 26% higher water content was documented in the soil. Regarding minimum soil disturbance, Thierfelder et al. (2022, pp. 166, 169, & 175) proposed no-tillage plus crop residue retention as a solution for the sustainable development of soil carbon and suitable investment in soil organic matter in maize fields in Zimbabwe. In their study, the relationship between soil physicochemical properties and maize productivity varied by soil type. They suggest that especially sandy soils should not be tilled. Ma et al. (2022, pp. 2145, 2150, & 2156) found that in vast areas of Kenya and Ethiopia, an integration of SM practices such as no-tillage, residue and manure application as well as cover crops can increase SOC levels (11%), carbon storage (4%), maize crop yield (22%) and overall crop production (18%). These measures promote food security and more sustainable agricultural production in the long term. As a result, SM practices can eventually contribute to enhancing soil health with a perspective on climate change mitigation and, subsequently, boost agricultural productivity in SSA (Nde et al., 2023, pp. 77, 86, 89, & 91).

Depending on the regional conditions concerning soil type, climate, precipitation, farming system etc., soil management to increase humus content needs to be different. It is helpful to include measures applying compost and biochar in SM strategies as well as the next principle, agroforestry.

D) Agroforestry

Agroforestry has a long history, not only in SSA. As sustainability becomes increasingly important, agroforestry has moved into focus again because it combines the ecological, socioeconomic, and environmental benefits of both forestry and agriculture (Bucagu et al., 2013). Agroforestry systems consist of rotational cultivation of trees or shrubs with agricultural crops. As mentioned above, many people living in SSA directly depend on the agricultural sector and struggle with the adverse impacts of climate change. Especially among smallholder farmers, agroforestry systems have great potential to enhance crop yields and to promote overall productivity toward meeting the ever-growing demand of SSA's population for grain food and moving to a climate-adaptive farming system (Kuyah et al., 2019; Muthee et al., 2022).

A good example is the leguminous *Faidherbia albida*, commonly intercropped with millet and groundnuts in SSA, which via leaf fall deposits on food crops substantial amounts of organic matter that acts like a fertilizer. Dense stands of *F. albida* (e.g., 50 large trees per ha) have been reported to produce a significant amount of green manure equivalent to almost 50 tons/ha/yr of manure. Studies on this combination of millet grown with *F. albida* in agroforestry systems increased grain and protein yields by a factor of 2.5 and 3.4, respectively (Mokgolodi et al., 2011).

Agroforestry systems and improved fallows (ranging from 1-5 years) have enhanced SOC and sequestered on average 2.2 (minimum 0.7 and maximum 8.3) tons of carbon/ha/yr (Partey et al., 2017; Kihara et al., 2020, pp. 1 & 7). According to Reppin et al. (2020, p. 203, 204, & 214), in an agroforestry system, total farm carbon stock is determined by the type of agroforestry practice, farm size, tree density, and the average size of trees on the farm. The dominant support services (60%) generated by agroforestry in SSA are soil formation and soil fertility (Muthee et al., 2022).

In a meta-analysis study by Muchane et al. (2020, pp 1, 12 & 20), it was estimated that the agroforestry system in humid and subhumid tropics of SSA could reduce soil erosion by 50% and increase SOC, available N, available P, and soil pH by 40%, 46%, 11%, and 2%, respectively, compared to monoculture cropping. Moreover, trees provide shade that reduces evaporation of water contained in soils and protects crops and soil biology from the negative effects of strong sunshine.

Therefore, agroforestry can significantly contribute to an agroecological transition towards high crop productivity, low crop failure, food security and restoration of degraded agroecosystems based on increasing SOC as well as to climate change adaptation and mitigation in SSA (Muchane et al., 2020; Muthee et al., 2022).

3. Call to action – Joint efforts can bring the transition

Establishing large-scale superior farming methods is necessary to accomplish the SDGs, especially to increase yield for a growing population and create better living conditions for farmers, but also to reduce GHG emissions, fight desertification and protect biodiversity. The combined action of different stakeholders in a joint effort is necessary to achieve this. Hence, the authors want to encourage organizations, private sector actors, practitioners, politicians, and individuals to add their pieces to the transition puzzle.

3.1. Calling on practitioners/farmers in the agricultural sector

BetterSoil farming methods based on the four principles outlined above must receive greater international attention in practice. In the end, it is the farmers that need to implement them. Although the agricultural sector is responsible for approximately one quarter of global GHG emissions, farmers cannot be blamed for the whole agricultural system. Often, they suffer from exploitative conditions and injustice. However, if conditions are set up correctly, farmers can build the bridge between different academic and political silos and become protectors of biodiversity and the climate, while also providing high-quality food for societies. For soil improvement, it is necessary to close the carbon and nitrogen cycle in the soil. Because the primary cause of climate change is imbalance in open geochemical cycles, soils as the major carbon reservoir on land play a big role. Here, it is important that farmers working towards these goals be rewarded.

Mid- to long-term, the benefits significantly outweigh the costs. But, depending on the specific situation, short-term financial or practical support is often needed for the transition from the current farming system to one furthering soil humus formation. Finally, implementing betterSoil practices strengthens the resilience of farms against the adverse effects of climate change. Such practices are thus an investment in soils, which are the capital of farmers and of our societies.

From the participation of Ethiopia, Kenya, and Tanzania in implementing soil management practices we have evidence for comparing farmers' experience and knowledge about soil health with scientific measures. A study supports including farmers as effective monitoring participants in regard to soil health benefits to increase the knowledge exchange between farmers and scientists promoting practices for soil improvement. This is a good contribution of farmers in evaluating the schemes for soil restoration in East Africa (Entz et al., 2022, pp. 1 & 13).

3.2. Calling on the private sector (industry, entrepreneurs, and business leaders)

Increasingly, the global economy is facing multiple crises simultaneously. For years, countries in dry areas have been experiencing the effects of a changing climate. Recently, environmental extremes like water scarcity, drought, and wildfires during dry periods, as well as heavy rainfalls, have also been experienced by high-income countries in Europe and North America. For companies, these effects lead to increased operational costs, destroyed capital, higher general risk, and distorted business models through supply chain disruptions. A stable economy needs a stable environment and stable societies. For the decades to come, this means that resilience of the economic system needs to be improved.

Although costs caused by adverse climatic effects and biodiversity loss are difficult to quantify, prospects are clear: the higher the temperature rises, the bigger the problems become. Hence, most companies have an economic self-interest to work on climate and biodiversity protection. Companies with (global) supply chains in the agricultural sector already feel those effects. Many of them start acting already, but the pace should increase. Companies outside the agricultural sector also need stable economic and social conditions. Consequently, they too have reason to support better soil practices toward promoting the SDGs and protecting the climate and biodiversity so as to reduce detrimental instability in the overall system.

People reflexively refer to governments to work on solutions when raising issues like poverty, climate change, or biodiversity. But can they address these issues? Do they have the resources? Not fully. Currently, the private sector has five to seven times more wealth and capital than states (Alvaredo et al., 2018). Worldwide government spending on sustainability issues is on the order of hundreds of billions of dollars. Estimates show, however, that effective solutions require trillions rather than billions. The longer we wait, the higher the costs will be.

When farmers want to change their system to a targeted humus economy to close the carbon and nitrogen cycles, they need financial support at least for some years in the transition. Organizations like betterSoil likewise need financial support to help in this transition. Through voluntary action, companies can provide this support. This helps them, too, because it works towards a stable economy and an overall decrease in economic inefficiency. Contributing to the SDGs and ensuring climate and biodiversity protection is becoming increasingly important when considering the operating license. Employees want to know whether they are working for a company that cares and uses its influence for a better world. Consumers want to buy products from companies living up to high values. Legislation recently also increased pressure on companies to support sustainability. The European Corporate Sustainability Reporting Directive requires companies to report about different sustainability indicators.

May companies live up to their great responsibilities commensurate to their capabilities!

3.3. Calling on governments

Each state has its own expertise and responsibility. To encourage more policy makers and practitioners to protect the climate and to promote economic development, states should implement betterSoil practices in their countries and encourage them through their policies. When adopting betterSoil practices, they should give small-scale farmers economic and political support toward making their food production more resilient to climate change and economic disturbances.

In SSA, several projects and initiatives aim to promote and integrate sustainable agricultural land management practices among small-holder farmers. For example, Vi Agroforestry's Kenya Agricultural Carbon Project trains approximately 30,000 small-holder farmers (small farm size area <2.5 ha) in Western Kenya in agroforestry, cover cropping, composting, and organic manure management, to improve soil health and C sequestration in croplands, and ultimately to improve crop yields and economic returns (Nyberg et al., 2020). Such initiatives also enhance small-holder farmers' resilience to climate variability and change.

Governments can provide the right framework for effectively applying the betterSoil principles. Collaborating with scientists and practitioners, they can shape regulatory incentives, e.g., by subsidizing beneficial measures and penalizing negative externalities like GHG emissions. Across continents and income levels, governments should act together in co-financing betterSoil practices. Oftentimes for example costs for carbon removals and avoidance strategies are much higher in high-income countries than in low-income countries. Furthermore, implemented in the latter, climate protection measures can create all the mentioned co-benefits regarding the SDGs, thus creating a win-win situation.

May states collaborate in providing mutually beneficial incentives for efficient (financial) resource allocation!

3.4. Calling on the African Union

The United Nations (UN) has declared the years 2021-2030 as the UN Decade on Ecosystem Restoration. With this initiative, global restoration efforts should be promoted to reach the necessary scale. Especially for Africa, this decade provides enormous restoration opportunities because the continent has a large need and substantial potential for restoration. For the UN Decade on Ecosystem Restoration to be successful, it must succeed in Africa. Prompt identification of opportunities is important to ensure proper planning and successful implementation of restoration initiatives in Africa (Nsikani et al., 2023). To restore degraded African soils and increase their fertility, to bind atmospheric CO_2 in the soil and directly contribute to climate resilience, the African Union (AU) should place greater emphasis on betterSoil practices and humus enhancement in its agricultural policies. The betterSoil principles can also support the Comprehensive African Agricultural Development Program to develop resilient agriculture in African nations. This Program and the African Agenda 2063, "The Africa we Want," provide a good foundation for increased action on healthy soils.

Farmers and actors involved in food production should be rewarded for actions that help close nitrogen and carbon cycles, which means avoiding, reducing, and removing atmospheric GHGs to benefit the climate (Nsikani et al., 2023). Moreover, the AU should also demonstrate greater commitment to support African initiatives, such as AFR100 (the African Forest Landscape Restoration Initiative), to restore an estimated 100 million hectares of land by 2030. However, for such pan-African initiatives to be successful and to contribute to the 'Africa, we Want', the AU and its member states must be the main partners for a successful mobilization of financial and technical resources as the foundation for country-specific implementation strategies. Herein, the coordination at the state level in Africa and multilateral cooperation with, e.g., the European Union, are of utmost importance. This may include but is not limited to biodiversity conservation, forest and ecosystem rehabilitation and restoration, rangeland management, and climate-positive as well as regenerative agricultural practices. Ultimately, these initiatives will galvanize 'sustainable solutions for land restoration and drought resilience, with a strong focus on future-proofing land use,' (FAO and UNCCD, 2022) as envisaged by UNCCD's 197 Parties at COP15. Connecting restoration efforts with the Nationally Determined Contributions that states have submitted pursuant to the Paris Agreement can increase the efficiency of envisaged measures.

May the AU continue to raise its pan-African voice to increase the efficiency of multilateral cooperation, which is needed more than ever.

3.5. Calling on individuals all around the world

Joining initiatives to improve soil health is highly recommended. Recruit at least two people from your family, friends, or colleagues and inspire actors from the private and political sectors to become more engaged in global climate protection and sustainable development through betterSoil practices. This topic needs more awareness of societies, their governments, and their decision-makers. Acting as a betterSoil ambassador, promoting the benefits of betterSoil solutions can create this awareness. Give financial support to farmers and projects that use betterSoil farming methods locally and worldwide. Encourage your political representative to work on soil improvement policies. Encourage your employer to set up a strategy aligned with the values of a responsible business benefitting societies and not only increasing shareholder value – yes, working on soils can bring these components together, especially in cases where business models directly depend on sustainable supply chains. Become a net climate-neutral individual and become involved in promoting the topic, as your contribution is crucial for advancing the global puzzle towards a better world.

Individuals, raise your voices and connect to promote grassroots support for soil improvement.

4. Conclusion and outlook

The science is clear: sustainable farming practices enhancing humus in soils – applying betterSoil principles – have enormous potential to protect the climate and biodiversity and to support the SDGs (Figure 1). Therefore, this paper seeks to attract the attention of all stakeholders to promote the application of betterSoil farming practices. This also promotes actions at the AU and global levels through ministries, non-governmental organizations, the UN, the Food and Agriculture Organization (FAO), the Committee on World Food Security and the High-Level Panel of Experts (in parallel with their existing actions and demands to enhance humus content of our soils), and many others.

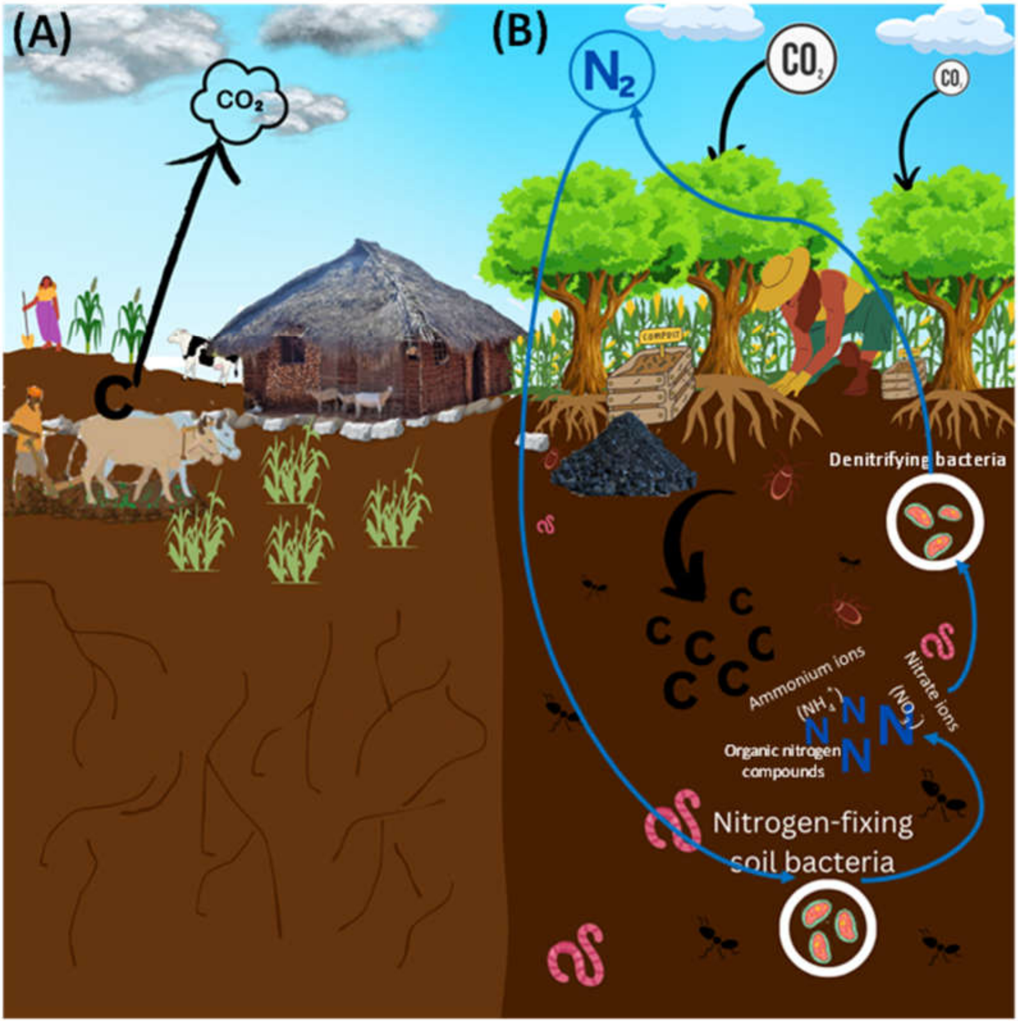

Figure 1. Schematic representation of (A) without betterSoil vs. (B) with betterSoil agricultural principles

As an organization, betterSoil is part of a universe of individual organizations and actors that already work on soil improvement; some even have experience for decades. Only the combined power of groups of politicians, investors, farmers, scientists, practitioners, and students can push our joint agenda forward. We welcome all individuals and entities to join a global movement for collaborative action to put scientific and indigenous knowledge into practice. Overall, healthy soils are the foundation of all life on earth, including your life as you read this paper! We are what we eat – and our food is either grown on healthy or non-healthy soil.

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Research Paper

The Synergy of Food Sovereignty and the Politics of Malnutrition in Tanzania: What Works, Why and How?

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Abstract: Recent data from Tanzania's National Bureau of Statistics show the alarming extent of malnutrition: 35% of under-five children classified as stunted and 15% as underweight, demanding urgent intervention. This paper investigates the synergy between food sovereignty and politics of malnutrition in Tanzania, examining mechanisms, effectiveness, and strategies. It asserts that the interplay between food sovereignty and politics of malnutrition drives socio-economic progress and food security. Using a case study approach, the paper evaluates scalable food sovereignty projects in Tanzania. Interviews with stakeholders, including officials, non-governmental organizations (NGOs), and experts, offered insights into the complex relationship. The paper explores "food sovereignty" theory alignment with case studies (the What), rationale for realizing the right-to-food in Tanzania (the Why), and operationalizing policies amid the "politics of malnutrition" (the How). The paper draws on political ecology theory by Bryant and Bailey to explore food sovereignty-malnutrition synergy. Findings reveal that successful food sovereignty projects enhance food security and reduce child malnutrition. Factors include agroecological practices, traditional food systems, women and youth engagement, and community resource mobilization, empowering communities and prioritizing nutrition. Food sovereignty proves transformative in Tanzania and similar contexts, yet structural/political changes are vital to challenging industrial agriculture and global markets. In general, the success of food sovereignty projects in addressing malnutrition in Tanzania illustrates the potential of food sovereignty as a transformative approach to addressing food insecurity and malnutrition. However, achieving food sovereignty requires challenging the dominance of industrial agriculture and global food markets.

Keywords:

1. Agriculture
2. Food sovereignty
3. Malnutrition
4. Policy reforms
5. Structural transformation
6. Tanzania

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1. Introduction

Holt-Giménez and Altieri (2012) define food sovereignty as the right of people to access healthy and culturally appropriate food produced sustainably, while Patel (2009) underscores its significance as a human right. Globally, empirical studies (La Via Campesina, 2003; Rosset, 2006; Holt-Giménez, 2011; Bliss et al., 2018) highlight the role of food sovereignty in addressing malnutrition, particularly in developing countries.

The research establishes that political factors play a pivotal role in malnutrition, including power concentration in the food system and globalization (Holt-Giménez, 2011). Food sovereignty emerges as a potential solution by promoting local food systems and empowering small-scale farmers. The emphasis is placed on the potential for alignment between the food sovereignty and nutrition outcomes (Clapp & Fuchs, 2018) and a dialogue-based approach is proposed for convergence (Bliss et al., 2018). Case studies from different countries including Malawi and Brazil (Hélène et al., 2019) illustrate food sovereignty's potential to enhance nutrition outcomes.

However, the power dynamics within communities and the broader political landscape impact the effectiveness of food sovereignty initiatives (Bliss et al., 2018; Popkin, 2014). Cultural factors are also intertwined with the politics of malnutrition (Loopstra & Tarasuk, 2012; FAO, 2013). Addressing scalability and policy barriers (Rosset, 2013; Alkon & Agyeman, 2011) are crucial for successful implementation.

The politics of malnutrition in Tanzania encompasses various issues, such as poverty, limited access to healthcare and education, and insufficient progress in right-to-food policies (UNICEF, 2019). This paper, therefore, examined the theoretical concept of food sovereignty, its alignment with the right-to-food in Tanzania, and practical implications for addressing malnutrition within a political, social, and cultural context.

2. Food Sovereignty and Politics of Malnutrition in Tanzania

The challenge of malnutrition in Tanzania is a complex interplay of political, socio-cultural, economic, and environmental factors (UNICEF, 2021). Despite efforts to combat this issue through right-to-food policies, alternative approaches to food security and nutrition are essential. This synthesis of Tanzanian literature examines the potential synergy between food sovereignty and the politics of malnutrition within this context.

At the heart of this discussion lies the theoretical concept of food sovereignty, advocating for community control over food systems (Wittman et al., 2010). This encompasses the right to culturally appropriate nourishment, local decision-making, and sustainable agriculture. In Tanzania, food sovereignty emerges as a transformative strategy against food insecurity and malnutrition (Magomba & Mdemu, 2019; Moyo et al., 2020). Pioneering studies underline the connection between food sovereignty and the right-to-food policy in Tanzania (Mbunda, 2016; Ndulo et al., 2020). Mbunda (2016) builds upon Sam Moyo's agrarian research, arguing for food sovereignty's role in enhancing self-sufficiency. Ndulo et al. (2020) concur, asserting that food sovereignty provides a framework to realize the right-to-food, necessitating structural shifts to challenge industrial agriculture and enhance food security.

Tanzania's food security challenges, particularly in rural areas, necessitate effective initiatives (Nziku et al., 2018). Programs like the Agricultural Sector Development Program and the National Food Reserve Agency aim to enhance agricultural productivity (Mengi & Kusiluka, 2017). However, these efforts encounter obstacles like funding shortages, infrastructure gaps, and climate-induced uncertainties.

Food sovereignty in Tanzania faces hurdles including land expropriation, urbanization, and corporate dominance (Lukumbuzya & Kiyombo, 2019). Land acquisitions for commercial purposes displace smallholders, impacting livelihoods and food access (Lukumbuzya & Kiyombo, 2019). Urban expansion further reduces arable land for food production. Corporate dominance marginalizes smallholders in the market (Lupala et al., 2021). Community-based initiatives, such as farmer cooperatives and agroecology, offer transformative potential (Lupala et al., 2021). As such, examining the politics of malnutrition, Pawlos (2018) defines it as encompassing political, economic, and socio-cultural factors. Tanzania's childhood malnutrition prompts policies like the National Multisectoral Nutrition Action Plan and the Scaling Up Nutrition Movement (Kubaha et al., 2019). These initiatives grapple with challenges like funding, health system weaknesses, and limited community engagement.

Addressing food sovereignty and the politics of malnutrition in Tanzania necessitates a comprehensive interdisciplinary approach. Community engagement, small-scale farming, and local food systems are crucial for food justice and sovereignty. Investment in infrastructure, technology, and sustainable agriculture advances food security. Confronting root causes, strengthening health systems, and community engagement are pivotal in shaping the politics of malnutrition. Moreover, the political ecology theory, as outlined by Bryant and Bailey (1997), offers a lens for understanding the intricate interplay between ecological and political dynamics in the context of food sovereignty and malnutrition. This theory emphasizes how political-economic structures and power relations shape resource access, distribution, and environmental outcomes. Through integrating the political ecology perspective, we gain deeper insights into the complex web of factors influencing food systems, resource allocation, and their impact on malnutrition in Tanzania. The interconnections between political power, ecological processes, and human well-being become evident through this theoretical framework, providing a holistic understanding of the dynamics at play.

3. Study Sites and Research Methods

In this study, an exploratory multiple-case design was employed to investigate the intricate relationship between food sovereignty and the politics of malnutrition in Tanzania. The study selected a diverse range of seven case studies to ensure a rich and comprehensive understanding of the research topic. These cases were specifically chosen for their potential to provide in-depth insights into the dynamics of food sovereignty and malnutrition in Tanzania. The selected cases are:

- MVIWATA (*Mtandao wa Vikundi Vya Wakulima Tanzania*). This network of farmer groups in Tanzania played a significant role in advocating for farmers' rights and sustainable agricultural practices, aiming to enhance food sovereignty and nutrition outcomes.
- Community-led Nutrition Intervention Program in Mwanza Region. This case focused on a localized nutrition intervention program led by the community in the Mwanza Region. It aimed to improve access to nutritious food and enhance food sovereignty at the local level.
- Women's Land Rights and Access to Food in Kilimanjaro Region. This case explored how women's land rights and access to resources in the Kilimanjaro Region influenced their ability to contribute to food sovereignty and address malnutrition.
- Kilimo Kwanza (Agriculture First). This government-led initiative aimed to promote agricultural development and enhance food security in Tanzania. The case study examined its impact on food sovereignty and nutrition outcomes.

- Community Health Workers in Arusha Region. This case delved into the role of community health workers in promoting nutrition and food sovereignty at the grassroots level through education, awareness, and local interventions.
- Community-Based Seed Systems in Ruvuma Region. This case study investigated community-based efforts to preserve and promote traditional seed systems, contributing to food sovereignty and nutritional diversity.
- Sustainable Agriculture Tanzania in Morogoro Region: This organization's sustainable agriculture practices were examined for their potential to empower communities, enhance food sovereignty, and address malnutrition.

The choice of a multiple-case design offered several advantages, such as robust and reliable evidence, a deeper understanding of the research phenomenon, and the exploration of theoretical evolution and research questions. By analyzing these diverse cases, the researchers were able to comprehend how contextual factors, including political, economic, and socio-cultural influences, shaped the outcomes related to food sovereignty and malnutrition. However, it's important to acknowledge that this design incurred costs in terms of time and finances, as noted by Gustafsson (2017).

Regarding the data collection methods, this study utilized qualitative approaches such as case studies, focus group discussions, and key informant interviews. Moreover, the study reviewed grey literature, particularly program/project reports. By employing various qualitative methods, the data triangulation was achieved, and the perspectives of multiple stakeholders, including small-scale farmers, policymakers, local communities, and other relevant parties, were captured on issues related to food sovereignty and malnutrition in Tanzania. The selected case studies provided in-depth information about specific initiatives and programs that have effectively promoted food sovereignty and improved nutrition outcomes. Focus group discussions and key informant interviews with government officials, civil society organizations, community leaders, and experts were conducted to identify the barriers and challenges faced by communities in controlling their food systems and addressing malnutrition. Overall, the use of multiple methods in data collection provided a comprehensive understanding of the subject matter.

Furthermore, the research adopted a participatory action research (PAR) approach to involve communities and stakeholders in the research process. PAR is a collaborative and iterative process that includes problem identification, data collection, analysis, and action with the aim of empowering communities and promoting social change. Communities were involved in identifying their needs and priorities, developing and implementing interventions, and evaluating the effectiveness of those interventions.

The study utilized a thematic analysis approach for data analysis, which followed the steps outlined by Braun and Clarke (2006). The process of data analysis involved becoming familiar with the data, coding by labeling sentences and paragraphs, and combining codes to generate themes. A deductive or top-down approach was used in generating the themes, meaning that the identification of themes was driven by the researcher's theoretical interest (theory-led thematic analysis). However, the researchers also ensured that this was done in a way that allowed for the emergence of new insights that might not be explained by the guiding theoretical framework.

After generating the themes, a thematic matrix was utilized to describe the relationships between food sovereignty and malnutrition. The thematic matrix helped organize the data into a table, which was used to identify the different themes and the relationships between them. The matrix also aided in identifying patterns within the data, making it easier to analyze the findings and draw conclusions. Overall, the thematic analysis approach provided a rigorous and systematic method for analyzing the data collected through various qualitative methods.

4. Experiences and Perspectives of Stakeholders on Food Sovereignty and Malnutrition in Tanzania

This paper delves into the experiences and perspectives of various stakeholders regarding the intertwined issues of food sovereignty and malnutrition in Tanzania. It sheds light on the challenges faced by small-scale farmers and communities in accessing land, a critical resource for food production. As articulated by a small-scale farmer from Kilimanjaro in 2023 below, limited access to land, government and commercial ownership of prime land and lack of control over land hinder their ability to produce sufficient food for their families and local communities.

> *"We have very limited access to land. The government and big commercial farmers own most of the good land, and they don't want to give it to us. We can't invest in our own land, and we don't have control over it. This makes it very difficult for us to produce enough food for our families and communities"* (Small-scale farmer from Women's Land Rights and Access to Food in Kilimanjaro Region, 2023).

The statement by the small-scale farmer from Kilimanjaro underscores a critical concern within the broader context of food sovereignty and malnutrition in Tanzania. Land access and ownership are foundational elements of food sovereignty, a concept emphasizing the right of communities to control their own food systems. The challenges faced by small-scale farmers in accessing land directly impact their ability to produce nutritious and culturally appropriate food for themselves and their communities.

The concentration of land ownership among government entities and large commercial farmers exacerbates inequality and restricts the ability of small-scale farmers to cultivate and manage their own food production. This structural imbalance perpetuates a cycle of limited food access, contributing to malnutrition and other related health issues.

Furthermore, the lack of control over land undermines the autonomy of small-scale farmers, making it difficult for them to make long-term investments in sustainable agricultural practices. This, in turn, hampers efforts to enhance food security and nutrition at the local level. The experiences shared by the small-scale farmer in Kilimanjaro resonate with broader discussions on land access and food sovereignty in Tanzania. According to Mngumi et al. (2020), land concentration and limited access have led to unequal distribution of resources, which directly impacts food sovereignty. The study by Nchimbi et al. (2019) highlights how unequal land distribution and lack of tenure security among small-scale farmers hinder agricultural productivity and exacerbate malnutrition.

In a similar vein, the statement aligns with the findings of Kabeer and Mahmud (2009), who emphasize the significance of asset ownership, including land, in empowering marginalized communities to achieve food security and nutrition. Their research highlights that without secure access to resources such as land, communities are unable to break free from the cycle of poverty and food insecurity. Furthermore, the issues raised by the small-scale farmer reflect the broader policy context in Tanzania. Kilahama and Kilasara (2015) argue that policy frameworks promoting large-scale investments in agriculture often sideline the interests of small-scale farmers, leading to land dispossession and reduced food sovereignty. The stakeholder's perspective encapsulates the challenges faced by small-scale farmers in realizing their right to food sovereignty and underscores the urgent need for equitable land distribution and supportive policies to address malnutrition and enhance sustainable food systems in Tanzania. Table 1 below distils discussions on views of stakeholders from participatory action research (PAR) with stakeholders that offer a comprehensive overview of the distinct aspects affecting small-scale farmers, government policies, and commercial farmers drawing on political ecology theory. Table 1 shows that small-scale farmers encounter limited access to land, which curtails their ability to invest in agricultural production and exercise control. In contrast, government policies exhibit a dominant control over land ownership, while commercial farmers benefit from privileged access. This stark disparity aligns with the concerns raised by small-scale farmers in Kilimanjaro, emphasizing the challenge of land ownership and its impact on food sovereignty.

Table 1. Views of Stakeholders on Power Relations on Different Aspects

Aspect	**Small-scale Farmers**	**Government Policies**	**Commercial Farmers**
Land Ownership	*Limited access*	*Dominant control*	*Privileged access*
Food Production	*Insufficient*	*Mixed outcomes*	*High production*
Nutritional Status	*Poor*	*Varied*	*Generally good*
Community Impact	*Limited resources*	*Government impact*	*Economic benefits*
Access to Resources	*Inadequate*	*Varied*	*Abundant resources*
Household Food Security	*Insecure*	*Mixed results*	*Generally secure*
Empowerment and Autonomy	*Limited*	*Controlled*	*High autonomy*

Source: Survey 2023

The data reveals that, small-scale farmers struggle with insufficient food production, resulting in poor nutritional outcomes. Government policies, on the other hand, yield mixed results in terms of food production and nutritional impact. Commercial farmers, empowered by their privileged access to resources, achieve high levels of production and maintain generally good nutritional statuses. This discrepancy highlights the role of resource availability and access in influencing food production and nutritional well-being.

Small-scale farmers and their communities contend with limited resources, leading to challenges in ensuring adequate food availability. Government policies have a considerable impact on these communities, while commercial farmers reap economic benefits from their abundant resources and opportunities. This distinction underscores the far-reaching consequences of resource disparities on community well-being.

The data underscores that small-scale farmers experience low household food security due to their constrained access to resources and limited autonomy. Government policies exhibit mixed results in ensuring household food security, whereas commercial farmers, with their high autonomy and abundant resources, tend to enjoy generally secure food access. This variation emphasizes the multifaceted nature of food security and its intricate ties to resource control and autonomy.

The findings presented in this table align with broader literature on food sovereignty and malnutrition in Tanzania. Research by Mngumi et al. (2020) highlights the challenges faced by small-scale farmers in accessing land and resources, contributing to insufficient food production and poor nutritional outcomes. Furthermore, Kilahama & Kilasara (2015) discusses the influence of government policies on food production and community impact, echoing the mixed outcomes observed in this study. In contrast, studies by Kabeer & Mahmud (2009) emphasize the importance of empowering small-scale farmers and communities to enhance autonomy and food security, aligning with the disparities identified in this analysis.

Additionally, Table 2 below presents a comprehensive overview of field data sets pertaining to the experiences and perspectives of stakeholders on food sovereignty and malnutrition in Tanzania, in line with the concerns raised by the community members and PAR stakeholders.

Table 2. Views of Stakeholders on Food Sovereignty and Malnutrition in Tanzania

Aspect	**Small-scale Farmers**	**Government Policies**	**Commercial Farmers**
Access to Traditional Practices	*High involvement*	*Moderate support*	*Neglected*
Local Food Systems	*Strong reliance*	*Partial integration*	*Neglected*
Agriculture Focus	*Diverse crops*	*Mixed priorities*	*Cash crops for export*
Food Sovereignty Promotion	*Limited empowerment*	*Moderate efforts*	*Limited emphasis*
Malnutrition Prevalence	*High incidence*	*Varied outcomes*	*Lower incidence*

Source: Survey 2023

The small-scale farmers in Table 2 are heavily involved in traditional farming practices and rely on local food systems for sustenance. Government policies show moderate support for these practices, but commercial agriculture tends to neglect them. This neglect has led to a disconnect between traditional methods and modern farming approaches, impacting food sovereignty.

The small-scale farmers further engage in diverse crop cultivation, contributing to local food diversity. Government policies exhibit mixed priorities in balancing local and commercial needs. However, commercial agriculture, driven by export demands, emphasizes cash crops over local food production. This trend challenges the promotion of food sovereignty and negatively affects the nutritional diversity available to communities.

Likewise, the data suggests a high incidence of malnutrition among small-scale farmers, possibly due to limited access to resources and diverse foods. Government policies yield varied outcomes, while commercial farmers experience lower malnutrition rates, possibly due to their higher production capacities and income levels.

The findings underline the dominance of commercial agriculture in Tanzania and its effects on traditional farming practices and local food systems. This aligns with the neglect of traditional practices and local food systems observed by Nchimbi et al. (2019). Furthermore, Mngumi et al. (2020) underscore the influence of international trade policies and multinational corporations on local food systems. This is consistent with the shift towards cash crop production for export seen among commercial farmers, contributing to food insecurity and malnutrition, as indicated by the high malnutrition prevalence among small-scale farmers. Therefore, the field statistical data sets presented in the Table 2, along with the insights provided by the policymaker, shed light on the challenges faced by small-scale farmers, government policies, and commercial agriculture in promoting food sovereignty and combating malnutrition in Tanzania. The findings reinforce the need for policy interventions that prioritize local food systems, empower small-scale farmers, and address the influence of global market forces on achieving sustainable food security and nutrition outcomes.

5. Case Studies of Successful Food Sovereignty Initiatives and Programs in Tanzania

The success of food sovereignty initiatives and programs in Tanzania was determined by a combination of factors that contribute to their effectiveness, impact, and sustainability. The following are the criteria used to identify successful case studies.

- Community Engagement and Empowerment. Successful initiatives often prioritize active participation and engagement of local communities and stakeholders (Altieri & Toledo, 2011). Empowering communities to make decisions about their food systems fosters ownership and sustainable practices (Wittman, 2011).
- Agroecological Approaches. Adopting agroecological practices, such as diversified cropping systems and reduced chemical inputs, is a key factor in successful food sovereignty initiatives (De Schutter, 2010).
- Access to Resources. Ensuring access to essential resources like land, water, and seeds is critical (Rosset et al., 2011). Securing land tenure rights for small-scale farmers supports their ability to practice agroecology (La Via Campesina, 2003).
- Local Knowledge and Traditions. Integrating local knowledge and traditional practices in agricultural systems contributes to their success (Scoones, 2009). Incorporating indigenous practices can enhance food security and ecosystem resilience (Mekuria & Aynekulu, 2018).
- Gender Equity. Addressing gender disparities and promoting women's involvement in decision-making positively influences the outcomes of food sovereignty initiatives (Doss, 2002; FAO, 2011).
- Capacity Building. Providing training and capacity-building programs to farmers enhances their skills and knowledge (Gliessman, 2014). Farmer-to-farmer knowledge sharing also contributes to successful outcomes (Vandermeer et al., 2010).
- Social Networks and Alliances. Collaborative networks and alliances among farmers, NGOs, research institutions, and other stakeholders amplify the impact of initiatives (Altieri, 2004).
- Adaptation to Local Contexts. Tailoring initiatives to a region's specific ecological, cultural, and socio-economic context contributes to their success (Vandermeer et al., 2010).

These determinants interact and contribute to the overall success of food sovereignty initiatives and programs, fostering resilience, sustainable food production, and improved livelihoods for small-scale farmers. Therefore, the study adopted PAR as an approach that involves community members and stakeholders in the research process to address issues that affect their lives. PAR was used in the context of food sovereignty initiatives and programs in Tanzania to ensure that communities and stakeholders are involved in decision-making and planning processes.

Based on the criteria, four out of seven case studies met the standards of food sovereignty initiatives and programs in Tanzania. Through PAR community members and stakeholders were able to share their knowledge, experiences, and perspectives on the issues that affect their food security and sovereignty for the successful initiatives as indicated below.

The case study of MVIWATA (*Mtandao wa Vikundi Vya Wakulima Tanzania*), or the Tanzania Farmers' Network, provides valuable insights into successful food sovereignty initiatives and programs in Tanzania, particularly through the lens of PAR principles.

MVIWATA is a grassroots movement dedicated to advocating for the rights of small-scale farmers, aiming to ensure that they have control over sustainable production systems. Aligning with the concept of food sovereignty, MVIWATA emphasizes local community control over food systems and resources for producing culturally appropriate and healthy food.

MVIWATA's establishment of successful farmers' markets is a prime example of community-led initiative. These markets provide a direct platform for small-scale farmers to sell their produce to consumers, eliminating intermediaries and ensuring fair income distribution. This approach resonates with PAR principles, which emphasize active involvement and decision-making by the local community (Reason & Bradbury, 2008). Similarly, MVIWATA's advocacy efforts align with PAR's participatory nature. The movement engages with government officials to promote policies supporting small-scale farmers and organic farming practices. This collaboration signifies the participatory dimension of PAR, where community voices influence policy changes and development (Reason & Bradbury, 2008).

MVIWATA's focus on sustainable agricultural practices, such as organic farming, mirrors the PAR principle of action and reflection. Through hands-on engagement, small-scale farmers learn and adapt sustainable techniques. This iterative process aligns with PAR's cyclical nature of planning, action, observation, and reflection (Reason & Bradbury, 2008). Furthermore, MVIWATA's case study demonstrates alignment with several core PAR principles, as follows. Participation – MVIWATA actively involves small-scale farmers in decision-making processes, reflecting the foundational PAR principle (Reason & Bradbury, 2008). Empowerment – by advocating for farmers' rights and facilitating cooperative initiatives, MVIWATA empowers farmers to take control of their livelihoods and food systems, in line with PAR's emphasis on empowerment (Reason & Bradbury, 2008). Local Knowledge – MVIWATA's promotion of sustainable agricultural practices incorporates local knowledge and traditions, respecting the PAR principle of valuing local expertise (Reason & Bradbury, 2008). Action and Reflection – the establishment of farmers' markets and collaboration with government officials exemplify the PAR cycle of taking action, reflecting on outcomes, and refining strategies (Reason & Bradbury, 2008). The case study of the community-led nutrition intervention program in the Mwanza Region of Tanzania offers valuable insights into successful food sovereignty initiatives that address malnutrition, aligning with the PAR principles. The program's community-led approach is a fundamental principle of PAR, reflecting active involvement and decision-making by local communities (Reason & Bradbury, 2008). Local communities were engaged in the program's development and implementation, ensuring cultural appropriateness and sustainability. Likewise, the provision of nutrition education aligns with PAR's emphasis on knowledge sharing and awareness-raising. Similar to PAR's reflection phase, where participants analyze and interpret information (Reason & Bradbury, 2008), the program aimed to enhance understanding of balanced diets and nutritional value to combat malnutrition.

The community-led nutrition intervention program in the Mwanza Region demonstrates alignment with several core PAR principles. Participation – the program's community-led approach exemplifies the essence of participation, involving local communities in decision-making, design, and implementation (Reason & Bradbury, 2008). Empowerment – the program empowers community members through hands-on involvement in kitchen gardens and nutrition education resonates with PAR's empowerment principle, fostering active engagement and learning (Reason & Bradbury, 2008). Local Knowledge – emphasizing traditional foods, the program preserves local knowledge and food cultures, aligning with PAR's respect for local expertise and practices (Reason & Bradbury, 2008). Action and Reflection – the establishment of kitchen gardens and nutritional education embodies the PAR cycle of taking action, reflecting on outcomes, and refining strategies for continuous improvement (Reason & Bradbury, 2008). The case study of the community-led initiative focusing on women's land rights and access to food in the Kilimanjaro Region of Tanzania serves as a compelling exemplification of the successful application of PAR principles, effectively contributing to the promotion of gender equality, women's empowerment, and the advancement of food sovereignty. This initiative's findings reveal crucial aspects.

First, the initiative's emphasis on granting women access to land aligns harmoniously with the PAR empowerment principle, allowing participants to seize control over their livelihoods and agency within their communities (Reason & Bradbury, 2008). This approach effectively disrupts entrenched gender norms by granting women the opportunity to own and cultivate land, thereby catalyzing gender equality. Second, the participatory nature of the initiative is evident through the collaborative process of identifying and allocating land to women. This mirrors the essence of PAR, fostering active community engagement in decision-making, akin to the participatory principle of involving stakeholders at all stages (Reason & Bradbury, 2008). Moreover, the program's commitment to training and promoting sustainable farming practices resonates with the PAR action and reflection cycle. This cycle parallels the practical learning process within the initiative, where women acquire skills, apply them, reflect on outcomes, and adapt strategies for continuous improvement (Reason & Bradbury, 2008).

The initiative aptly exemplifies the participatory approach, showcasing the active participation of women and the community throughout decision-making and implementation, thus reflecting the participatory essence that PAR champions (Reason & Bradbury, 2008). The empowerment of women facilitated by land access and training, is in direct harmony with the PAR empowerment principle, empowering women to take charge of their food production and income generation, mirroring PAR's underlying philosophy (Gliessman, 2014). The initiative's utilization of local knowledge and resources to address challenges resonates with PAR's principle of valuing community members' expertise, further enhancing the initiative's effectiveness (Mekuria & Aynekulu, 2018). Additionally, the initiative's multifaceted approach, encompassing land allocation, training, and cooperative establishment, closely follows the PAR cycle of action, reflection, and adaptation, reflecting a commitment to ongoing enhancement (Reason & Bradbury, 2008).

The Community-Based Seed Systems (CBSS) initiative is a key component of the food sovereignty movement in Tanzania. Launched in 1999, the initiative promotes farmer-led seed production and conservation, and aims to increase farmers' control over their seed systems. The CBSS program provides farmers with training in seed selection, conservation, and production techniques, as well as access to markets for their seed. By promoting the use of local seed varieties that are better adapted to local environmental conditions, the initiative helps increase crop yields and improves food security in rural communities.

Moreover, the CBSS initiative is aligned with the principles of food sovereignty, which emphasizes the importance of local communities having control over their food production and distribution systems. Through the initiative, farmers are able to maintain their traditional knowledge and practices around seed production and conservation, and are empowered to make decisions about their seed systems.

The CBSS initiative has been successful in promoting farmer-led seed production and conservation in Tanzania. By providing farmers with access to training and markets, the initiative has helped increase farmers' incomes and improved their livelihoods. Additionally, the use of local seed varieties has helped maintain biodiversity and preserve traditional knowledge around seed production and conservation.

Therefore, the CBSS initiative is an important component of the food sovereignty movement in Tanzania. By promoting farmer-led seed production and conservation, the initiative helps empower local communities and increase their control over their food systems, while also improving food security and preserving traditional knowledge and practices.

The Sustainable Agriculture Tanzania (SAT) initiative emerges as a pivotal catalyst within the food sovereignty movement in Tanzania, serving as a prime example of the effective application of PAR principles to foster sustainable agriculture, amplify the empowerment of smallholder farmers, and advance the cause of food sovereignty. The initiative's outcomes unveil noteworthy aspects.

Foremost, the SAT initiative's dedication to training farmers in agro-ecology and sustainable farming practices seamlessly aligns with the PAR principle of action and reflection. By engaging farmers in hands-on learning and practical implementation, SAT embodies the iterative PAR process, where actions and reflections coalesce for perpetual enhancement (Reason & Bradbury, 2008). Additionally, SAT's emphasis on empowering smallholder farmers to assume control over their food production and distribution systems resonates profoundly with the PAR empowerment principle. Akin to PAR's core tenet of participant agency and decision-making, the initiative gives participants the capability to steer their agricultural pursuits (Kilahama & Kilasara, 2015).

Moreover, the SAT initiative's coherence with food sovereignty principles mirrors the participatory essence of PAR. By enabling local communities to wield authority over their food systems, the initiative mirrors PAR's directive to encompass stakeholders across all stages of the process (Reason & Bradbury, 2008).

The SAT initiative conspicuously mirrors a range of essential PAR principles. Participation – the active engagement of smallholder farmers in agro-ecology training mirrors PAR's participatory core, underscoring the engagement of community members in hands-on endeavors and decision-making (Reason & Bradbury, 2008). Empowerment – equipping farmers with sustainable practices knowledge and tools aligns seamlessly with the PAR empowerment principle, nurturing the participants' influence over their agricultural endeavors (Nchimbi et al., 2019). Local Expertise and Practices – the emphasis on agro-ecology and traditional farming techniques adeptly encapsulates the PAR principle of valuing indigenous knowledge and expertise (Reason & Bradbury, 2008). Action and Reflection – the cyclical process of training and implementing sustainable farming techniques mirrors the PAR action and reflection cycle, where actions intertwine with reflection and evolution for sustained betterment (Reason & Bradbury, 2008).

Generally, the SAT initiative stands as a compelling testament to the realization of PAR principles within prosperous food sovereignty endeavors. Through inculcating sustainable practices, fostering empowerment, and empowering local control, the initiative augments not only food security and the economic viability of farmers but also preserves ancestral wisdom and safeguards the environment. This case study underscores the pivotal role of community-driven endeavors in nurturing sustainable agriculture, enhancing the agency of smallholder farmers, and concretizing the aspirations of food sovereignty.

These case studies demonstrate the importance of community-led initiatives, the recognition of women's rights, and government policy changes in promoting food security, sovereignty, and the reduction of malnutrition in Tanzania.

6. Summary of Lessons Learned from The Cases Presented

The analyzed case studies offer valuable insights into the promotion of sustainable and community-driven food systems in Tanzania. The cases speak to the six principles of food sovereignty (focuses on food for people, values food providers, localises food systems, puts control locally, builds knowledge and skills, and works with nature). MVIWATA, a grassroots movement, advocates for the rights of small-scale farmers. Through the implementation of successful farmers' markets, MVIWATA has improved consumers' access to healthy and nutritious food while sidestepping intermediaries and bolstering food security. Similarly, a community-led nutrition intervention program in the Mwanza Region addressed malnutrition by providing nutrition education and establishing school, health facility, and community center kitchen gardens. This program had a significant impact on improving the nutritional status of children and mothers in the area. Another community-led initiative, Women's Land Rights and Access to Food in the Kilimanjaro Region, aimed to provide land access, resources, and training and support for sustainable farming practices. The establishment of a women-led food cooperative further encouraged local food systems and supported women farmers' livelihoods. Finally, the government-led Kilimo Kwanza initiative endeavors to drive economic growth in Tanzania by investing in agriculture, financing small-scale farmers, and modernizing the sector.

7. Policy Change for Sustainable Food Production in Tanzania

In Tanzania, food security is a critical issue that affects, especially those in rural areas, the livelihoods of many people who rely on agriculture for their survival (Kilasara & Nandonde, 2016). In response to this challenge, the Tanzanian government has implemented policy changes aimed at promoting sustainable food production and improving food security in the country (URT, 2016).

One of the key policy changes has been increased investments in agriculture (URT, 2018). The government has allocated more resources towards agriculture, including funding for research and development, infrastructure development, and farmer education and training (URT, 2016). These investments have helped improve agricultural productivity and support small-scale farmers, who are the backbone of the Tanzanian agriculture sector (Kilimo Trust, 2018).

Another policy change has been the promotion of sustainable farming practices (Kilasara & Kilasara, 2019). The government has encouraged farmers to adopt sustainable farming methods, such as conservation agriculture, which can help increase crop yields, improve soil health, and reduce the use of harmful chemicals (Nhemachena & Hassan, 2019). The government has also supported the establishment of farmer field schools, which provide training and education on sustainable farming practices (Mattee & Hella, 2018).

In addition, the government has established food reserves to ensure access to food during times of scarcity (URT, 2013). These reserves provide a buffer against food shortages and help stabilize food prices. The government has also implemented policies to promote local food production and reduce dependence on imported food (Mkumbwa & Lwelamira, 2017).

These policy changes have been successful in improving food security and promoting sustainable food production in Tanzania (World Bank, 2015). Investing in agriculture has helped increase agricultural productivity, while promoting sustainable farming practices has raised the quality and quantity of food produced (Thompson and Yu, 2019). The establishment of food reserves has helped ensure access to food during times of scarcity, while the promotion of local food production has helped support the livelihoods of small-scale farmers (Makala & Sieber, 2018).

In general, the policy changes implemented by Tanzania's government provide an encouraging example of how policy can support sustainable food production and improve food security. They highlight the importance of investing in agriculture, promoting sustainable farming practices, and supporting local food production toward achieving Sustainable Development Goals.

8. Interventions and Policies for the Synergy of Food Sovereignty and the Politics of Malnutrition

As defined in the previous section, food sovereignty is the right of communities to determine their own food and agricultural systems, and to produce and consume healthy and culturally appropriate food in a sustainable manner (Holt-Giménez & Altieri, 2012). However, in Tanzania, like in many other countries, malnutrition remains a major public health issue, with a significant proportion of the population experiencing food insecurity and undernutrition. To address this issue, interventions and policies are needed that promote the synergy of food sovereignty and the politics of malnutrition. A PAR approach was used to involve communities and stakeholders in the development of these interventions and policies. PAR was collaborative and democratic involving community members, researchers, and stakeholders in the research process. The approach aimed to empower communities and to promote social change through the creation of new knowledge and the development of solutions to social problems. Therefore, using a PAR approach, communities and stakeholders in Tanzania were involved in identifying the root causes of malnutrition and food insecurity, as well as in addressing interventions and policies to address these issues. Interventions and policies that highly preferred to promote the synergy of food sovereignty and the politics of malnutrition include:

8.1. Investment in agriculture

This was substantiated by one of the policymakers who stated:

> *"The government needs to invest in modern agricultural techniques and infrastructure to increase food production. This will ensure food security, reduce reliance on food imports, and promote food sovereignty"* (Policymaker, Kilimanjaro, 2023).

This statement emphasizes the importance of government investment in modern agricultural techniques and infrastructure to increase food production in Tanzania. By investing in modern techniques and infrastructure, the government can help ensure food security, reduce reliance on food imports, and promote food sovereignty. These investments include improving irrigation systems, providing access to better seeds and fertilizers, and investing in research and development to improve crop yields and efficiency. By involving local communities in these efforts through a PAR approach, the government can ensure that interventions and policies are relevant and effective for addressing local needs and challenges.

8.2. Promoting sustainable agriculture practices

This was verified by one of the respondents in the community who stated:

> *"The government needs to promote sustainable agriculture practices such as crop rotation, agroforestry, and conservation agriculture to improve soil health and enhance food production. These practices also help reduce the use of harmful chemicals that contribute to malnutrition"* (Small-scale farmers from Community-led Nutrition Intervention Program in Mwanza Region, 2023).

The statement highlights the importance of promoting sustainable agricultural practices to enhance food production and reduce malnutrition. It emphasizes the need for the government to invest in promoting practices such as crop rotation, agroforestry, and conservation agriculture. These practices are known to improve soil health, increase crop yields, and reduce the use of harmful chemicals that can lead to malnutrition. By promoting sustainable agriculture practices, the government can support food sovereignty, reduce the dependence on food imports, and improve the nutritional status of its citizens.

8.3. Supporting small-scale farmers

During a focus group discussion (FGD), participants expressed the need for the government to support small-scale farmers in Tanzania. According to one participant:

> *"The government should support small-scale farmers by providing them with access to credit, technical assistance, and market opportunities. This will enable them to produce more food and earn a decent income"* (Small-scale farmers from Sustainable Agriculture Tanzania (SAT) in Morogoro Region, 2023).

The FGD participants emphasized the importance of supporting small-scale farmers who make up the majority of Tanzania's agricultural sector. Many of these farmers face significant challenges, such as limited access to credit, technical knowledge, and markets. Without adequate support, they struggle to produce enough food to meet their own needs, let alone contribute to national food security.

Participants highlighted the need for the government to provide small-scale farmers with access to credit and other forms of financial support, such as grants or subsidies. This would enable them to invest in their farms, purchase necessary inputs, and expand their production. Additionally, participants called for the government to provide technical assistance and training to farmers, particularly in sustainable farming practices such as crop rotation, agroforestry, and conservation agriculture. By adopting these practices, farmers can improve soil health, reduce their reliance on costly inputs such as fertilizers, and increase their yields over the long term.

Finally, participants emphasized the need for the government to support small-scale farmers by creating market opportunities for them. This could involve establishing local markets, connecting farmers with buyers, or providing support for value-added processing. By enabling small-scale farmers to sell their products at fair prices, the government can help them earn a decent income and contribute to national food security.

8.4. Food fortification

During one FGD one participant expressed:

> *"The government needs to enforce mandatory food fortification to address micronutrient deficiencies. This can be achieved by adding essential vitamins and minerals to staple foods like maize flour, wheat flour, and cooking oil."* (Small-scale farmer from Women's Land Rights and Access to Food in Kilimanjaro Region, 2023).

The FGD participant suggests that the government should enforce mandatory food fortification to address micronutrient deficiencies in Tanzania. This could be achieved by adding essential vitamins and minerals to staple foods like maize flour, wheat flour, and cooking oil. The participant emphasizes that this approach would be an effective way of improving the nutritional status of the population, especially vulnerable groups such as pregnant women and young children. Additionally, the participant calls on the government to ensure that the fortification process is monitored and regulated so that the added nutrients are at appropriate levels and cause no adverse health effects.

8.5. Nutrition education

The government needs to provide nutrition education to communities, especially women, on the importance of a balanced diet and the benefits of breastfeeding. This will help reduce malnutrition rates and improve overall health outcomes. This was corroborated by one of the policymakers who stated:

> *"We believe that the government should prioritize providing nutrition education to communities, especially women, on the importance of a balanced diet and the benefits of breastfeeding. This will not only help reduce malnutrition rates but also improve overall health outcomes in the country. It's important to involve community health workers, local leaders, and other stakeholders in disseminating this information to ensure that it reaches everyone. Additionally, the government should also invest in the promotion of locally available nutritious foods to encourage the consumption of diverse and healthy diets"* (Policymaker, Dar es Salaam, 2023).

8.6. Social protection programs

During FGD one participant expressed:

> *"The government should implement and improve where necessary social protection programs such as cash transfers, food vouchers, and school feeding programs to ensure vulnerable populations have access to food"* (Small-scale farmer, from MVIWATA Morogoro, 2023).

This quotation emphasizes the need for social protection programs to ensure that vulnerable populations have access to food. These programs can include cash transfers, food vouchers, and school feeding programs.

8.7. Strengthening food systems

The FGD quotation suggests that:

> *"The government should strengthen food systems by improving food storage, transportation, and processing. This will help reduce food waste and ensure food is available all year round"* (Small-scale farmer from Community-led Nutrition Intervention Program in Mwanza Region, 2023).

This highlights the importance of addressing the various stages of the food system to ensure food security and sovereignty. By improving food storage facilities, such as warehouses and silos, the government can reduce food waste and prevent food loss due to spoilage. Improving transportation infrastructure, such as roads and bridges, can also help farmers reach markets more easily and reduce food waste. Moreover, investing in food processing technology can help extend the shelf life of perishable foods and increase their value, thereby providing opportunities for small-scale farmers to earn a better income. Overall, improving the food system is crucial to achieving food sovereignty and addressing malnutrition in Tanzania.

8.8. Addressing the root causes of food insecurity

The government should address the root causes of food insecurity, such as poverty, by implementing poverty reduction strategies and creating employment opportunities. This was corroborated by one of the policy makers who stated:

> *"The root causes of food insecurity, such as poverty, need to be addressed by the government through the implementation of poverty reduction strategies and the creation of employment opportunities. This will enable individuals and households to have the means to access food and improve their nutritional status."* (Policymaker, Dar es Salaam, 2023).

8.9. Collaborative partnerships

Collaborative partnerships among the government, civil society, and the private sector can help address food justice, security, and sovereignty issues. This can include promoting local food production, reducing food waste, and increasing access to markets. This was supported by one of the stakeholders who stated:

> *"Collaborative partnerships between the government, civil society, and the private sector are crucial for addressing food justice, security, and sovereignty issues. Through these partnerships, we can promote local food production, reduce food waste, and increase access to markets. It's important to work together to find innovative solutions to these complex issues and to ensure that everyone has access to nutritious, culturally appropriate, and sustainable food"* (NGO's manager, Mwanza, 2023).

8.10. Research and data collection

The government should invest in research and data collection to better understand the causes of malnutrition and to develop evidence-based policies and interventions to address them. This was verified by one of the policy makers who stated:

> *"The government could invest in research and data collection to gain a better understanding of the underlying causes of malnutrition in Tanzania. By doing so, they can develop effective, evidence-based policies and interventions to address malnutrition and promote food sovereignty"* (Small-scale farmer from Community-led Nutrition Intervention Program in Mwanza Region, 2023).

The above interventions and policies can help promote food justice, security, sovereignty, and reduce malnutrition in Tanzania. However, these efforts need to be sustained over the long term to achieve meaningful and lasting impact.

9. Discussions on the Findings

The discussion on the synergy of food sovereignty and the politics of malnutrition in Tanzania highlights the importance of promoting sustainable food systems that are community-led and prioritize local food production. The case studies presented here demonstrate how grassroots movements, community-led interventions, and government policies can work together to promote food sovereignty and address malnutrition.

One of the key takeaways from the discussion is the importance of investing in agriculture to support small-scale farmers who are the backbone of Tanzania's agriculture sector. The government's allocation of more resources towards agriculture, including funding for research and development, infrastructure development, and farmer education and training, has helped improve agricultural productivity and support small-scale farmers.

Another key takeaway is the promotion of community-led sustainable farming practices, which can help increase crop yields, improve soil health, and reduce the use of harmful chemicals. The government's encouragement of farmers to adopt sustainable farming methods, such as conservation agriculture, and the establishment of farmer field schools to provide training and education on sustainable farming practices have been successful in improving food security and promoting sustainable food production in Tanzania.

The establishment of food reserves and the promotion of local food production are other policy changes that have been successful in improving food security in Tanzania. The government's efforts to reduce dependence on imported food and promote local food production have led to a reduction in food imports and increased availability of locally produced foods. This has contributed to improved food security and reduced vulnerability to external shocks.

In general, the findings highlight the importance of promoting food sovereignty and sustainable food systems to address malnutrition in Tanzania. This requires a multi-faceted approach that involves grassroots movements, community-led interventions, and government policies. Investments in agriculture, promotion of sustainable farming practices, establishment of food reserves, and promotion of local food production are all important components of this approach.

10. Conclusion

Tanzania confronts formidable obstacles on its path towards achieving food sovereignty, particularly among rural populations heavily reliant on agriculture for sustenance. The government has undertaken a series of policy reforms aimed at bolstering sustainable food production and enhancing overall food security within the nation. These policy shifts encompass increased investments in agriculture, advocacy for sustainable farming methodologies, fostering localized food cultivation, and establishment of farmer field schools and strategic food reserves. The execution of these policies has yielded tangible enhancements in agricultural productivity, subsequently fortifying food security and augmenting the livelihoods of small-scale farmers. Moreover, community-led initiatives, such as those effectively pioneered by MVIWATA and the community-led nutrition intervention program in the Mwanza Region, have been instrumental in redressing malnutrition and cultivating sustainable, community-oriented food systems.

Undoubtedly, the harmonious interplay between food sovereignty and the multifaceted dynamics of malnutrition's political underpinnings within Tanzania constitutes a linchpin in advancing sustainable food systems and amplifying overall food security. The embrace of food sovereignty empowers communities to assert authority over their individual food systems, ensuring that their nourishment is healthful, nutritious, and culturally resonant. In tandem, the intricate politics surrounding malnutrition delve into the bedrock causes of this affliction, encompassing poverty, inequality, and insufficient access to critical resources such as sustenance, healthcare, and education. The amalgamation of these complementary approaches stands as a potent strategy to engage the intricate malnutrition challenges pervasive in Tanzania, all while championing sustainable and community-driven food systems.

Proven triumphs within Tanzania's landscape, such as the impactful endeavors of MVIWATA, the community-led nutrition intervention programs, and initiatives advocating women's land rights, eloquently underscore the potency of these paradigms. Simultaneously, the government's recalibrated policy landscape comprising augmented investments in agriculture, the propagation of sustainable farming techniques, the establishment of strategic food reservoirs, and unwavering support for localized food cultivation has efficaciously elevated food security and promoted sustainable agricultural output throughout the nation.

The surge in agricultural investment spearheaded by Tanzania's government has invariably spurred heightened productivity and fortified the foundations of small-scale farming. This newfound emphasis on sustainable farming methods has precipitated improvements in both the quality and quantity of produce yielded. The strategic deployment of food reserves and the spirited drive for localized food production have collectively underwritten accessibility to sustenance and buoyed the fortunes of small-scale farming communities. It is also imperative to acknowledge the instrumental role played by grassroots movements like MVIWATA, amplifying the advocacy for organic farming practices, safeguarding the rights of small-scale farmers, and broadening access to wholesome and nourishing fare for consumers.

Concurrently, the ascendancy of community-led nutrition intervention programs has unfurled commendable success in augmenting the nutritional well-being of children and mothers within the region. Equally meritorious is the inception of women-led food cooperatives, invigorating local food systems while simultaneously bolstering the livelihoods of female farmers. Collectively, these diverse avenues of progress demonstrate the remarkable strides made by Tanzania in its pursuit of sustainable food production and fortified food security.

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Research Paper

Harnessing the Untapped Potential of Youth Agripreneurship in Creating Employment and Food Security in Africa

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Abstract: Agripreneurship has huge potential to create employment, especially for youths and women, and thereby to reduce poverty in Africa. It is among the most promising sectors in Africa and an essential driver of economic development. But this potential has yet to be tapped. Through a review of relevant literature, this paper highlights the role of agripreneurship in creating youth employment in Africa and further highlights strategies for job creation for youth in agriculture. Secondary data was gathered from databases such as Google Scholar, John Wiley, Springer, SAGE, Scopus, and Taylor and Francis. If properly integrated, youth have the capacity to drive socio-economic development in Africa. However, despite its enormous potential, more work must be done to effectively incorporate youth in agripreneurship in Africa. The findings further indicate that youth participation in agribusiness can enhance youth employment and food production in Africa. Increased efforts to integrate youth into the food system will reduce the incidence of crime and poverty on the African continent. Government and development sector players must collaborate and form coalitions to tackle the challenge of youth unemployment collectively rather than in silos. Proper strategies and integration of youth in agripreneurship will increase job creation, food security, and income for many African farmers.

Keywords:

1. Africa
2. Agripreneurship
3. Employment creation
4. Food system

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1. Introduction

With about 60% of its total population below 25, Africa is the youngest continent in the world. Africa also has a large youth population, with over 420 million people aged between 15 and 35 (Geza et al., 2022). This demographic presents a significant economic growth and development opportunity but also poses substantial challenges, such as high unemployment rates, poverty, and social unrest (Addo, 2018). This situation is made even more challenging by the COVID-19 pandemic, which has caused job losses and reduced economic growth in many African countries (Rogito & Rogito, 2022).

Agriculture has the potential to provide employment opportunities for young people in Africa. Agriculture is the backbone of many African economies, employing over 60% of the continent's labor force, with women and youth making up a significant portion (Geza et al., 2022). The agricultural sector has the potential to create 17 million jobs for young people by 2025, thereby also alleviating food insecurity in Africa. But this potential is yet to be tapped (Adeyanju et al., 2021).

Agripreneurship, defined as entrepreneurship in the agricultural sector, is one way to harness the potential of agriculture for youth employment and food security. Agripreneurship offers opportunities for innovation, value addition, and market linkages, which can lead to higher incomes for farmers and increased food production. However, despite its enormous potential, more work needs to be done to effectively integrate young people into the sector (Boye et al., 2022).

The agriculture sector faces challenges that limit its potential to create employment for young people (Okello, 2020). One of the significant challenges facing youth agripreneurship in Africa is limited access to finance, which is a critical factor in the success of agribusiness ventures. Many young people need more collateral to secure loans from financial institutions (Muyanga et al., 2021). Limited access to land is also a significant challenge facing young agripreneurs in Africa. Land tenure systems in many African countries are complex, and young people often lack the resources to acquire land and to access markets for their products (Adeyanju et al., 2023). Inadequate training and skills are also significant challenges facing young agripreneurs in Africa, limiting their ability to develop viable businesses and to compete in local and international markets (Ray et al., 2022).

This paper provides background on youth agripreneurship, highlighting its potential for promoting youth employment and food security in Africa. It suggests strategies for creating jobs for youths in agriculture, discussing challenges and interventions needed. Providing new ideas for stimulating momentum toward achieving Africa's Agenda 2063, the Sustainable Development Goals, and the United Nations food system pathways, the paper calls for collaborative efforts to unlock the potential of youth agripreneurship in Africa.

2. Agripreneurship in Africa

Agripreneurship has been described as the intersection of agriculture and entrepreneurship, involving innovative business models to create value and generate income. It combines agricultural activities with entrepreneurial principles to generate economic, social, and environmental benefits (Geza et al., 2021). The concept of agripreneurship is gaining traction in Africa due to the continent's vast agricultural resources and the need for sustainable food systems, employment creation, and economic growth (Akrong & Kotu, 2022).

2.1. Overview of Youth Engagement in Agripreneurship in Africa

Agribusiness has enormous potential to address youth unemployment and food insecurity in Africa. However, more work must be done to effectively integrate youth into the sector. Most youths in Africa view agriculture as a traditional and less profitable sector. Hence, they tend to shy away from it. However, there is a growing recognition that agripreneurship can provide viable employment opportunities for African youth. Recent studies have shown that African youth engagement in agripreneurship is rising (Aremu et al., 2021).

Nigeria's government has launched various initiatives to encourage youth engagement in agripreneurship. The Youth Employment in Agriculture Program (YEAP) provides training, mentorship, and start-up capital to young people interested in agripreneurship. The programme has successfully created employment opportunities for young people and reduced poverty levels. Ghana's government, too, has launched several initiatives to support youth farmers. The National Youth in Agriculture Programme (NYAP) provides training, financial support, and market links to young people interested in agripreneurship. NYAP has successfully created employment opportunities for young people and improved food security in the country (Adeyanju et al., 2023).

However, despite such progress in promoting youth engagement in agripreneurship in Africa, there are still challenges to be addressed. These include access to finance, access to land, inadequate infrastructure, and limited market access. Addressing these challenges will require a collaborative effort from all stakeholders, including government, private sector, civil society, and development partners (Ouko et al., 2022). Young people's participation in agribusiness is critical for addressing youth unemployment and food insecurity in Africa (Zulu et al., 2021).

Agripreneurship presents an opportunity to address these challenges by creating innovative business models that are more efficient, productive, and profitable (Som et al., 2018). Agripreneurship can also address youth unemployment in Africa, a significant challenge facing the continent. Ude (2020) states that over 60% of Africa's youth are unemployed, threatening social and economic stability. Agripreneurship allows youth to create businesses, generate income, and contribute to the economy (Turolla et al., 2022).

2.2. Potential of Agripreneurship

Africa is a continent that has been grappling with high levels of unemployment, especially among young people. Unemployment in Africa is a major challenge that requires immediate attention, and agribusiness has emerged as one of the most promising sectors to address this challenge.

Agripreneurship offers enormous employment potential due to its large labour absorption capacity, particularly among youth and women (Ray et al., 2022). The sector has the potential to create employment opportunities in various areas, including the production, processing, distribution, and marketing of agricultural products. The agriculture sector is a significant contributor to most African countries' gross domestic product (GDP). Addo (2018) states that the agriculture sector accounts for 15% to 35% of GDP in most African countries and employs more than 70% of the rural population.

A study by Ude (2020) found that most young people in Africa are not involved in agribusiness due to various factors, including limited access to finance, inadequate technical skills, and lack of information on agribusiness opportunities. The study also found that women face additional challenges, including limited access to land and lack of control over productive assets. The sector can significantly reduce youth unemployment and poverty levels on the continent. With proper strategies and integration of youth and women in agripreneurship, the sector can increase job creation, food security, and income (Magagula & Tsvakirai, 2020).

3. Challenges that hinder youth participation in agripreneurship in Africa

Agriculture has been identified as an important contributor to the economy of most African countries. However, youth participation in agriculture and agripreneurship still needs to improve despite the potential benefits that can be derived from it (Rogito & Nyakora, 2023). One of the main bottlenecks is the need for more access to land. In Africa, most of the arable land is owned by the government or large-scale farmers unwilling to lease or sell it to young agripreneurs. This creates a barrier to entry for young people who want to enter agribusiness.

Additionally, even when land is available, most young farmers need more knowledge and skills to optimize land use and productivity (Henning et al., 2022).

Lack of access to finance is one of the main challenges hindering youth participation in agripreneurship in Africa. Most African youth need more access to financial services such as loans, grants, and credit facilities. This limits their ability to invest in agriculture and agrientrepreneurship. According to Addo (2018), most financial institutions in Africa perceive agriculture as a high-risk sector, making it hard to obtain financing – especially for youths, who are perceived as high-risk borrowers by most financial institutions. The lack of access to finance further hinders the growth and expansion of agripreneurship ventures.

Youth engagement in agripreneurship in Africa is impeded also by lack of technical skills such as crop management, pest control, and marketing. Most agricultural training institutions in Africa do not provide practical training to youth, which limits their ability to acquire the necessary technical skills (Rogito et al., 2020).

Inadequate infrastructure poses another challenge that hinders youth participation in agriculture in Africa. Most African rural areas lack basic infrastructure such as roads, water, and electricity. This limits the ability of youths to transport their produce to market and to access essential services such as irrigation. Inadequate infrastructure in rural areas has resulted in high post-harvest losses, making it difficult for young people to engage in agriculture and agripreneurship.

Negative attitudes toward agriculture constitute another challenge: most African youths view agriculture as a low-income profession, which discourages them from engaging in agriculture and agripreneurship (De Mesa et al., 2022).

Limited access to information services is also a significant bottleneck that impedes youth participation in the agricultural value chain. Most young agripreneurs need access to relevant and up-to-date information on modern farming practices, market trends, and new technologies (Zulu et al., 2021), enabling them to adopt innovative practices that enhance productivity and profitability in their agripreneurship ventures. There is a need for concerted efforts by government and development sector players. One potential solution is for the government to implement progressive policies that support youth engagement in agripreneurship (Inoubli et al., 2022).

4. Strategies for job creation and youth integration in agripreneurship in Africa

To harness the untapped potential of youth agribusiness for job creation and food security in Africa, strategies must be developed to integrate youth into the agricultural sector. One of the key strategies for job creation and youth integration in agripreneurship is promoting entrepreneurial skills (Tindiwensi et al., 2023). This involves providing training and support to youth to develop their entrepreneurial skills in the agricultural sector. According to Addo (2018), promoting entrepreneurial skills among young people can create small and medium-sized agribusinesses, providing employment opportunities for young people.

Innovative technology is another important strategy for job creation and youth integration in agriculture. This involves using technology to increase productivity and efficiency in the agricultural sector. According to Boye et al. (2022), using innovative technology can reduce the labour requirements of agriculture, making it more attractive to youth who may view agriculture as a low-income profession.

Collaboration and partnership among different stakeholders in the agricultural sector constitute another important strategy for job creation and youth integration in agripreneurship (Aremu et al., 2021). This involves bringing together government, private sector, and other stakeholders to create an enabling environment for youth participation in agriculture and agribusiness. According to Turolla et al. (2022), collaboration can help address some of the challenges, such as lack of access to finance and inadequate infrastructure. Market access is another important strategy for job creation and youth integration into agriculture. This involves creating market links for youth agripreneurs to sell their produce at competitive prices (Alabi et al., 2019).

5. The potential of youth engagement in agribusiness for job creation and food security in Africa

The agricultural sector is predominantly made up of small-scale farmers who operate near the subsistence level and lack the resources and knowledge to improve their productivity. Youth engagement in agripreneurship presents an opportunity to increase agricultural productivity and to create employment opportunities. Young people have the potential to drive innovation and introduce new technologies and practices that can improve agricultural productivity, increase yields, and reduce post-harvest losses making it a critical sector for addressing youth unemployment in Africa (Rogito & Rogito, 2022).

The participation of young people in agriculture can also contribute to food security in Africa. Africa currently imports a significant proportion of its food, although the continent has the potential to become self-sufficient in food by increasing production (Henning et al., 2022). Young people can leverage their knowledge and skills to introduce new crops and farming practices that can increase yields and improve the nutritional value of food. This can contribute to the achievement of Sustainable Development Goal 2: an end to hunger and access to nutritious food for all. Africa's Agenda 2063 also emphasizes this goal (Akrong & Kotu, 2022).

Role of government and development sector players in supporting youth agriculture.

Youth can drive socio-economic development in Africa through agripreneurship. However, the potential of youth engagement in agripreneurship has not been fully exploited. This is partly due to lack of support from government and development sector players (Magbondé et al., 2023) which have a significant role to play in creating and sustaining an enabling environment for the agribusiness of young people. Government policies and initiatives can enhance the development of agripreneurship in several ways, including providing financial support, access to land, and information services. Financial support could be in the form of start-up capital or low-interest loans, enabling young people to start or expand their businesses (Rogito et al., 2020). Access to land and information services such as market information and weather forecasts are also crucial in improving the productivity and profitability of youth agriculture (Ouko et al., 2022).

Development sector players, including NGOs, international organizations, and private sector actors, can support youth agripreneurship through various initiatives. These initiatives include capacity building programs, technical assistance, and mentorship programs. Capacity building programmes can equip young people with the skills and knowledge to succeed in agripreneurship. Technical assistance and mentorship programs can provide them with guidance and support to start and growing their businesses (Rogito & Nyamota, 2022).

Several initiatives have been implemented to support young farmers in Africa. For instance, the African Development Bank (AfDB) launched the ENABLE Youth Program in 2016 to support youth engagement in agribusiness (Ude, 2020). The program provides financing, technical assistance, and mentorship to young agripreneurs in African countries. Similarly, the International Fund for Agricultural Development (IFAD) has several initiatives to support young entrepreneurs in Africa, including the Rural Youth Agribusiness Promotion Programme and the

Youth Employment in Agriculture Programme. The government and development sector players stimulate youth agripreneurship toward job creation and food security in Africa (Geza et al., 2022). Access to financial support, land, and information services as well as capacity building, and mentoring programs can help create an enabling environment for young agripreneurship (Okello et al., 2020).

6. Conclusion

Youths have the potential to drive socio-economic development in Africa through agripreneurship. However, despite the enormous potential, little work that has been done to integrate them into agripreneurship in Africa. Agripreneurship offers significant employment potential for African youth, especially in the agricultural sector. Youth participation in agriculture can create jobs, increase food production, and reduce poverty levels on the African continent. However, there is a need for heightened efforts to incorporate youths into the food system to fully achieve these benefits. To harness this potential, governments, development sector players, and all food system players should make concerted efforts (Rogito & Makabe, 2023). By working together, they can overcome the bottlenecks hindering youth engagement in agripreneurship and enable youths to drive socio-economic development in Africa.

7. Recommendations

To harness the untapped potential of youth agripreneurship toward the creation of employment and food security in Africa, the following recommendations are offered:

- Government and development sector players should collaborate and form coalitions to tackle the challenge of youth unemployment together. They should also work toward addressing the key bottlenecks hindering youth engagement in the agricultural value chain, such as access to land, finance, and information services.
- There is a need for capacity building and training programs to enable youths to participate effectively in agripreneurship. Governments and development sector players should provide financial support and start-up capital to enable youths to establish and operate agripreneurship ventures.
- Progressive policies should be developed to support youth engagement in agripreneurship. Such policies should provide incentives for youth involvement in agripreneurship, such as tax exemptions and subsidies for youth-led agripreneurship ventures.
- Coordinated efforts from all food system players towards youth agripreneurship should be encouraged. This will enable youths to access markets and input suppliers and also facilitate the sharing of knowledge and experiences among youth agripreneurs.

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Research Paper

Exploring the Viability of Utilizing Agricultural and Rural Areas for Tourism: A Comparative Analysis of Farming Between Conventional and Agritourism Farms during the COVID-19 pandemic

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Abstract: This study compares the performance of conventional and agritourism farming to investigate how the COVID-19 epidemic has affected agricultural efficiency. The study was carried out in Sub-Saharan Africa, particularly in Tanzania, due to a comparatively high concentration of agritourism and conventional farmers. Regression analysis and the slack-based measure data envelopment analysis model (SBM-DEA) are used in this study to assess farming efficiency and identify the critical variables influencing the productivity of conventional and agritourism farmers. The application of the comparative approach is what sets this paper apart, as most researchers tend to examine conventional farmers and agritourism farmers separately leading to a noticeable methodological gap. The results reveal a significant efficiency gap, where conventional farmers outperformed agritourism farmers. This result shows how vulnerable agritourism farming is to external disruptions exemplified by COVID-19-related disruptions. Moreover, the study identifies the positive influence of training and direct sales-to-consumers on efficiency, while recognizing the negative influence of lack of value addition and production of export crops. These insights are important for designing targeted strategies to ensure a sustainable recovery post-COVID-19.

Keywords:

1. Agritourism
2. Efficiency
3. SBM-DEA Model
4. Comparative Analysis
5. COVID-19

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1. Introduction

Agriculture and tourism are two critical sectors for socioeconomic development in Sub-Saharan countries like Tanzania as they generate a huge portion of employment opportunities, income, and foreign exchange earnings. In Tanzania, around 65% of the workforce is employed in the agriculture sector, which contributes 25% of the GDP (NBS, 2020). Similarly, Tanzania is a popular tourist destination, well-known for its wildlife, islands, and cultural attractions. The tourism sector creates employment in various areas, such as hotels, tour companies, restaurants, and related businesses. In 2019, the sector contributed around 17.5% to the nation's GDP and employed 11.1% of the workforce (UNWTO, 2020). Various studies suggest that the tourism industry holds the potential to reduce poverty and foster economic development in developing countries (Binns and Nel, 2002; Li et al., 2018; Liu and Wu, 2019; UNCTAD, 2004). In Tanzania, the tourism sector is used to reduce poverty through job creation and the market for traditional products (Odhiambo, 2011).

Now let's turn our focus to tourism-oriented diversification in agriculture. By combining the two sectors, agritourism has emerged as a unique form of diversification that has a positive impact on both ends. It helps farmers preserve and safeguard their rural environment while providing tourists with the chance to experience and enjoy a rural lifestyle (Sonnino, 2004). Agritourism also offers farmers a chance to improve their standard of living, opens up a new revenue stream, and creates a unique combination of tourism and agriculture-related activities. Agritourism can also offer a different market and an alternative distribution channel for farm products (Valdivia & Barbieri, 2014).

Tourism-oriented diversification has been recognized as an effective way to accelerate socioeconomic development in rural areas (Ohe & Kurihara, 2013). Additionally, it offers financial incentives to the local government and community to protect tourism resources, preserve traditional farming practices, and support a sustainable economy.

This type of diversification has resulted in the coexistence of two separate subsectors in Tanzania: agritourism and traditional farming. This study will broadly describe conventional farmers as those who just engage in traditional farming practices, without offering tourism-related experiences to visitors. And agritourism farmers will be broadly defined as individuals who own and operate farms or agricultural businesses actively providing touristic experiences. The agritourism sub-sector remains in its early stages of development and involves activities such as farm tours, agroforestry, and culinary services. In times of economic distress, such as a poor harvest or low prices, diversification strategies have been suggested to increase and stabilize farmers' incomes or to best supplement farm incomes (Kim et al., 2019). However, just as conventional farming is susceptible to external shocks like market fluctuations and climate change (Shemdoe, 2011), agritourism farming is also not immune to such shocks.

Both the conventional and agritourism subsectors experienced unparalleled disruption following the onset of the COVID-19 epidemic. As COVID-19 rapidly spread, many nations implemented strict measures to safeguard public health (Weible et al., 2020). These responses profoundly shocked the global economy (Ceylan, 2020), particularly affecting developing nations. As a result, the outbreak added huge damage to the already-vulnerable agritourism and the conventional farming subsector. While tourism-oriented diversification in the agricultural sector has been more popular recently in Sub-Saharan Africa (SSA), little research has been done on its economic resilience and effectiveness in times of crisis. The goal of the present research is to evaluate how the pandemic has differentially affected agritourism and traditional farming, with an emphasis on comparing farming productivity. The paper will also explore factors influencing the efficiency of the two groups of farmers during disruptions. Finally, the paper will recommend some insights on sustainable recovery for farmers and agricultural systems from periods of disruptions. Two questions are proposed:

- RQ1: Is there a significant efficiency gap between agritourism and conventional farmers during the pandemic?
- RQ2: What are the key factors that affect efficiency of both conventional and agritourism farmers?

The capacity of a farm to produce the highest level of output with the lowest amount of feasible inputs will be the definition of farming efficiency used in this paper (Chimai, 2011). Therefore, given the quantity of input utilized, efficient farms are those that are able to generate the maximum amount of revenue. In other words, an efficient farm uses its resources effectively to get the most value and to produce revenue while minimizing waste; conversely, inefficient farms are those that fail to utilize their inputs effectively to produce the same level of output compared to the most efficient farms in the sample (Odhiambo et al., 2004). Inefficient farms may needlessly require a higher level of inputs than necessary to produce the outputs they generate, indicating that they have not adapted well to the pandemic disruptions.

The results of this study can provide valuable insights for stakeholders aiming for a sustainable post-pandemic recovery for farmers and agricultural systems across Sub-Saharan Africa (Duguma et al., 2021; Gordon, 2020). Similarly, conflicts of interest between players in the agritourism subsector are an inevitable occurrence (Wang & Yotsumoto, 2019). Thus, the research findings may help policymakers in arriving at well-informed choices that yield mutual benefits among all stakeholders, particularly as they strive to recover from the COVID-19 pandemic. Finally, knowing what influences efficiency will equip farmers with some insights to withstand future economic disruptions.

The sections of this paper are organized as follows. Section 2 reviews Tanzania’s agriculture and tourism sectors, the emergence of tourism-oriented diversification, the impact of COVID-19, and the implementation of data envelopment analysis. Section 3 covers the study's methodology and background. Section 4 presents and discusses the results. Section 5 lays out the conclusion, recommendations, and further research. Section 6 elucidates the study's limitations.

2. Literature review

2.1. An overview of Tanzania’s agriculture and tourism sectors

Tanzania is a country with abundant resources for both agriculture and tourism. Agriculture in Tanzania is dominated by conventional farmers involved in cultivation of staple crops, livestock keeping, and subsistence farming (Kimaro & Hieronimo, 2014; Tanzania invests, 2020). Tanzania is also one of the most popular tourist destinations in sub-Saharan Africa. According to the World Tourism Organization, 2021, In 2019, Tanzania held a significant share of international tourism receipts in the region, ranking behind South Africa as the leader in terms of international tourism receipts. Tanzania’s economy is heavily dependent on the agricultural sector (Mwonge & Naho, 2021); But, the sector faces challenges like low productivity, price fluctuations, and limited market access, preventing it from realizing its full potential (World Bank, 2018). Moreover, Shemdoe (2011) mentioned climate variability, such as irregular rain patterns, periodic droughts, and flooding, as huge challenges in the agriculture sector. Similarly, the tourism sector faces its own set of challenges, including the seasonality of its operations, competition from other destinations, and a lack of diversification (OECD, 2014). Other studies argued that the leakage of tourism revenue is one of the biggest challenges (Boz, 2011; UNEPTIE, 2007). Tourism leakage occurs when revenue fails to remain or circulate within the host destination’s economy because it’s spent on imported goods and services, accommodations in foreign-owned hotels, and external payments such as travel agent commissions, tour operator profits, and revenue from foreign airlines (Boz, 2011; UNEPTIE, 2007). The challenges above emphasize the necessity for tourism-oriented diversification as a strategy to mitigate the issues in Sub-Saharan Africa, as discussed in the next section.

2.2. The emergence of tourism-oriented diversification

Agritourism has been more popular in recent years as a way for the agricultural sector to diversify. It gives farmers an opportunity to make extra revenue and broaden their horizons by engaging in activities beyond conventional farming practices (Lyon & Canovi, 2019). Along with helping farmers preserve agricultural viability and diversify rural economies, it offers visitors a unique chance to enjoy traditional rural hospitality, access to nature, and cultural experiences (Yang, 2012). Additionally, by guaranteeing that even marginalized rural populations actively participate in and profit from tourism, agritourism might play a vital role in establishing more inclusive and sustainable socio-economic growth in rural areas. A tourism-related poverty reduction plan has to include policies that promote quick and sustainable economic growth (Karunarathne et al., 2019). In principle, the exclusion of the local community hinders sustainability. Lastly, due to high competition in the tourism sector, countries are increasingly aiming to leverage and promote their natural resources as a strategic approach to attract more tourists (Plourde, 2003). This is achieved by strategically expanding and diversifying the range of attractions and services within a destination to appeal to a broader spectrum of tourists; these new tourism products, experiences, and services cater to different demographics of tourists. Consequently, if Sub-Saharan African countries like Tanzania fail to capitalize on this opportunity, they might find themselves in a disadvantaged position.

2.3. Economic susceptibility in the agriculture sector and the impact of covid-19

Tanzania's government imposed localized lockdowns around the country in response to the surge in COVID-19 cases that began in 2020 (Economic Commission for Africa, 2020). Restrictions on movement delayed time-sensitive tasks, which had an effect on the amount and quality of agricultural output. Disruptions in labor mobility, supply chains, and the availability of crucial farming inputs were the causes of the impacts (Ayanlade & Radeny, 2020; Wang et al., 2022). Due to the unforeseen labor supply disruption caused by the COVID-19 pandemic, it was difficult to fill production roles, which increased costs and decreased productivity (Wang et al., 2022). This added to the vulnerability associated with external shocks, such as climate change and market fluctuations. Similarly, amid its successful establishment, the trajectory of tourism-oriented diversification encountered an unforeseen disruption by COVID-19, inflicting a profound and devastating impact. The substantial negative consequences of movement restrictions on non-essential sectors, particularly the service and tourist industries, were brought to light by Arita et al. (2022).

2.4. Unexplored areas and gaps in the existing literature

Considering that agricultural systems and crop production in Sub-Saharan Africa are diverse and heterogeneous by nature (de Graaff et al., 2011), the impact of the COVID-19 disruption is unlikely to be uniform across the board (Ayanlade and Radeny, 2020). Different farmers undoubtedly have different capacities to react, adjust, and absorb the shocks from the disruption depending on aspects including crop types, agritourism engagement, age of farmers, value addition strategies, reliance on foreign markets, and training. Béné (2020) revealed that the ability of farmers to address the challenges posed by COVID-19 is deeply influenced by context, including factors like country-specific restrictions, socio-economic conditions, and integration within supply chains.

Despite the importance of tourism-oriented diversification in the agricultural sector, the empirical evidence of the impacts of COVID-19 on agricultural systems across Sub-Saharan Africa is notably limited. Previous research has consistently pointed to the need for a thorough investigation and comprehension of the effects of the COVID-19 disruption on different farmer groups (Cattivelli & Rusciano 2020; Darnhofer 2020; Gunther 2020; Henry 2020). Furthermore, existing literature has predominantly focused on conventional farming, ignoring the emerging sub-sector of agritourism; therefore, there is a contextual gap resulting from the prior studies' failure to consider the agritourism subsector. Lastly, as far as the authors know, there is a noticeable methodological gap involving the oversight of comparative analysis between the two categories of farmers in Sub-Sahara Africa, as most researchers tend to examine conventional farmers and agritourism farmers separately. The application of the comparative approach is what sets this paper apart. This study aims to bring a fresh perspective and lay the foundation for future researchers to examine variations in the impacts experienced by different sub-groups within a broader collective during disruptions. The use of data envelope analysis (DEA), which is not yet widely applied in the domains of agriculture and agritourism, would be another noteworthy contribution.

2.5. Data envelopment analysis (DEA) and DEA extensions

Data envelopment analysis (DEA) is a non-parametric approach used for the estimation of the efficiency of the decision-making units of companies, businesses, or farms (Cooper et al., 2007). It is employed to provide insights about how best to allocate resources to increase efficiency. For its implementation, the DEA approach only requires data on quantities produced and inputs used (Coelli et al., 2005). DEA analysis is appropriate for assessing farm efficiency in the context of this study as it does not need assumptions about farm production technology, can be used at any aggregate level, including the farm level, and allows multiple outputs and inputs (Perrigot et al., 2009). Two basic DEA models are the CCR (Charnes-Cooper-Rhodes), which assumes a constant return to scale, and the BCC (Banker-Charnes-Cooper), which assumes a variable return to scale (Cooper et al., 2007). Due to its radial design, which emphasizes reducing inputs and increasing outputs, these models, although being frequently used, have several drawbacks. As a result, non-radial models such as SBM models were developed. The Slack-Based Measure (SBM) of Efficiency (Tone, 2001) aims at maximizing the sum of the inputs and outputs slacks for each decision making unit (DMU) used in a sample. This model has an advantage since it considers unutilized resources in the evaluation of efficiency (Ohe, 2022).

Now let's turn our attention to DEA extensions. After getting the results of the DEA analysis, most researchers implement additional steps using the efficiency scores obtained for further analysis. The most used method is regression analysis, particularly the tobit regression model. The use of the Ordinary Least Square (OLS) model can give biased results because of the possibility of including zero values obtained in DEA analysis (Chang et al., 2022). To avoid biased results, the tobit model is preferred for exploring the socio-economic variables that are affecting the obtained efficiency scores (Gabdo et al.2018; Hassen et al. 2017).

3. Methods

A cross-sectional survey was carried out between September and November of 2022. The Arusha and Mwanza regions in Tanzania were selected due to the high concentration of agriculture and tourism activities. A single-stage sampling procedure was used for the selection of the respondents for interviews and the completion of the questionnaires. The primary respondents were farmers, but government officials were also included for additional information. Farmers were divided into two groups, namely 25 conventional farmers and 20 agritourism farmers. A random sampling technique was adapted to reduce bias and improve the generalizability of our findings (Keppel and Wickens, 2003). Ensuring that each member of the defined groups had an equal probability of being selected required the use of this technique.

Data on inputs utilized and outputs generated was gathered from both farmer groups. Revenue was the output variable, while the input factors were land size, labor cost, other material cost, and capital cost. This comprehensive approach ensured that the survey instrument included all relevant components of farming operations, hence strengthened the dataset.

The study employed a two-stage method for data analysis, whereby the input used and output generated by each farm are used as data in the first stage to estimate efficiency using a DEA model. And in the second stage, the efficiency scores of the DEA analysis were used as a dependent variable in a regression model. Since this paper touches on the topic of agritourism, which is a form of farm diversification, the Slack-Based Measure (SBM) was adopted. The SBM model is more adequate for farm diversification activities because excess inputs or shortfalls in outputs can be expected (Ohe, 2022). Furthermore, a bilateral model was used since two sets of inputs and outputs are being considered simultaneously in this study to assess the effectiveness of DMUs. The model assumed a constant return to scale (CRS) because the farms included in the sample had narrow variation and all decision-making units (DMUs) were at optimal scale (Javed et al., 2010). Additionally, the output-oriented super SBM model was used for cross-validation of the results of the SBM model, as it allows for a more robust assessment of the model's performance. In the output-oriented DEA model, the inputs are held fixed while aiming to maximize the outputs produced by the DMUs (Charnes et al., 1978; Farrel, 1957).

Because the analysis of efficiency scores is not enough to explain the factors that cause variation in efficiency, the study used the efficiency scores as dependent variables in a regression analysis for the determination of the factors influencing efficiency (Bojnec & Latruffe, 2008; Coelli et al., 2005). Since the DEA efficiency scores are bounded between 0 to 1, they are not normally distributed (Dhungana et al., 2004). For this reason, normal regression analysis is not suitable as the variables are partly continuous and partly discrete (Wooldridge, 2010). Hence, the tobit regression model was preferred (Cooper, 1999). In previous studies by Al-Mezeini et al. (2020), Dhungana et al. (2004), and Li et al. (2018), tobit analysis was applied after efficiency evaluation to detect the factors that affect the efficiencies. In our study, the variables that were anticipated to influence efficiency included age of farmers, level of education, number of crops produced, years of training, production of export crops, direct sales to consumers strategy, and value-added practices.

4. Results and Discussion

4.1. Comparative efficiency of farmers

Using data envelope analysis (DEA), farms were assessed to determine whether they were efficient or inefficient. This categorization is based on the ability of the farm to convert inputs into outputs relative to other farms included in the sample. Table 1 summarizes the variables that were used to estimate the model.

Table 1. Descriptive statistics of the Input and output variable used for DEA model

	Inputs				Output
Item	Land size (ha)	Material Cost (USD)	Labor Costs (USD)	Capital Cost (USD)	Revenue (USD)
Max	10	2200	5500	10000	12000
Min	0.5	100	200	400	500
Mean	4.6	963.3	2259.4	4153.3	5082.2
SD	2.8	660.6	1758.3	3059.8	3469.6

Note: DEA: data envelopment analysis; Source: Field survey, 2022.

The results of the bilateral SBM model show a significant efficiency gap, where conventional farmers outperform agritourism farmers. The same results were obtained by the output-oriented Super SBM model, thereby indicating a better fit of the data. The graphical representation of the relative efficiency is shown in Figure 1. Conventional farmers may have achieved greater efficiency scores because they primarily focused on producing food crops and did not rely much on the global market. According to Torero (2020) and Frelat et al. (2016), conventional farmers in Sub-Saharan Africa are largely responsible for growing a significant amount of food crops. During the COVID-19 pandemic, trade in food products experienced comparatively less disruption. This resilience in demand for food products is rooted in their essential nature for survival (Chenarides et al., 2021). Actually, as people stocked up and cooked more at home, there was an increase in demand for staple food crops like rice and maize. This increased demand pushed prices higher, increased conventional farmers' revenues, and made it easier for them to improve their efficiency compared to their counterparts. Conversely, agritourism farmers rely on revenue from both hospitality and agricultural production; And the hospitality part of the agritourism operation were heavily affected by COVID-19 restrictions leading to less efficiency. Moreover, implemented measures for maintaining health and safety protocols to keep staffs and visitors safe added to the cost of operation (Wang et al., 2022). Wang et al. (2022) compared tourism and non-tourism sector by examining the effects on output, basic price, and investment; The study found that there was a decrease in the prices of tourism goods while the prices of non-tourism goods increased owing to a demand shock. Additionally, the study found that the reduction in output in the tourism-related sector was substantially higher than that in non-tourism sectors like agriculture sector.

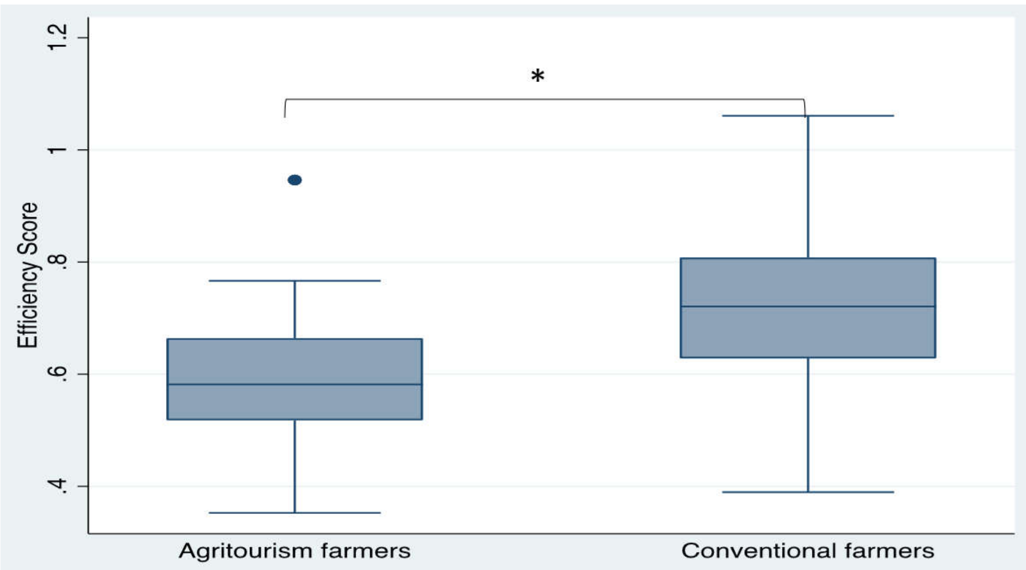

Figure 1. Boxplot of efficiency score by groups (Bilateral SBM-C)
Note: DEA: data envelopment analysis; SBM: Slack-based measure; (*) indicates 5% significance; Source: Field survey, 2022.

Additionally, due to low demand during the pandemic, harvest festivals and seasonal crop tours had to be canceled, which significantly decreased revenues. This resulted from either travel bans enforced by the government or travelers choosing to forego travel out of fear of catching the virus (Wang et al., 2022). The fact that agritourism farmers' activities did not fall under a category of important businesses made matters worse by limiting their access to government support. This might account for the comparatively lower efficiency shown, especially among those who were still in the pioneer stage.

The boxplots indicate that conventional farmers have a higher median efficiency score but a wider interquartile range (IQR) than conventional farmers, suggesting that conventional farmers are generally more efficient but have more variability in performance than agritourism farmers. The reason behind the disparity in efficiency for conventional farmers could be attributed to several factors: Firstly, some conventional farmers are involved in the cultivation of food crops that are not typical for domestic consumption. Products not directly tied to food consumption at home often show higher sensitivity to economic disruptions (Binkley & Liu, 2019). Other conventional farmers were impacted because they produced relatively expensive crops. This is because people became reluctant to purchase some expensive crop because of decreased income and financial uncertainty. Wang et al. (2022), showed that people focused on increasing savings and reducing consumption.

Further, variability in the efficiency score may also result from some conventional farmers' use of hired labor, particularly those with farms that are relatively larger than those of their peers. Harvesting, weeding, and planting were among the crucial farm management tasks that were delayed due to a manpower shortage. Meuwissen et al. (2020) found that smaller farms which rely mostly on family labor exhibited higher resilience than bigger farms that use hired labor. Lastly, some conventional farmers produced high-value perishable crops; as a result, supply chain disruption caused more severe post-harvest losses. When Varshney & Meenakshi (2023) analyzed the effects of COVID-19 on perishable and non-perishable goods, they found that the effects varied according on the type of goods. Food products were the most negatively impacted by trade restrictions because they were especially vulnerable to disruptions in transportation (WTO, 2020).

4.2. Factors influencing efficiency

This section presents a comprehensive analysis of several factors, including age, the number of crops, involvement in export crops, years of training abroad, direct sales to consumers, and involvement in value-addition. The independent variables that affect farmers' efficiency are shown in Table 2. The output indicates that the tobit regression model is significant at the 0.000 level. The LR chi2 value of 96.29 is significant at the 5% level (prob > chi2 = 0.0000), and a higher log-likelihood of 65.744 indicates that the model is a good fit for the data.

Table 2. The results of tobit regression

Score	Coefficient	t Static
Age (years)	-0.0051***	-3.74
Number of crops produced	7.088e-06	0.00
Years of training abroad	0.0393**	2.59
Export crops (export crop =1, food crops =0)	-0.0401*	-2.24
Direct sales to consumers (direct sales to consumer =1, Other	0.0761*	2.25
Value-added products (without = 1, with = 0)	-0.0454*	-2.30
Constant	0.8134***	9.99
LR Chi-Squire	96.29*	

Note: 1) ***, **, and * indicates 0.1% significance, 1% significance and 5% significance, respectively; Source: Field survey, 2022.

4.2.1. Age of the farmers

At a statistically significant level of 0.1%, the coefficient for the age of farmers in years showed a negative value, suggesting that an increasing in age is linked to a decrease in efficiency score. This may be related to the degree of adaptation and flexibility exhibited by farmers across various age groups. During Covid-19 pandemic, a quick adjustment was required due to supply chain disruption, changing market needs, and changed customer behavior. Hence, it became obvious that flexibility and adaptability were important. Unfortunately, older farmers were less flexible to the adjustments, which could have lowered their efficiency. Although useful, elder farmers' experience may have created a degree of rigidity that made it more difficult for them to face the challenges brought on by the COVID-19 pandemic. This observation aligns with Weeden (2008) and Fried & Tauer (2016), who observed a comparable negative correlation between farmers' age and efficiency. It's necessary to understand that age's impact extends beyond production to affect marketing efforts. To illustrate, Kamdem (2012), examining the relationship between farmers' age and marketing efficiency, found a negative effect. Contrastingly, Ohe (2020) observed that the age of the farmers had a positive relationship to business performance because the elder farmers could take good care of the visitors in tourism-oriented diversification. Other studies, indicated a different observation, where efficiency slightly increases with age before eventually decreasing (Lordkipanidze & Tauer, 2000; Tauer,1995).

4.2.2. Production of export crops and food crops

The coefficient associated with the production of export crops was negative, indicating a significant decrease in the efficiency score when engaged in the production of export crops at the 5% significance level. This suggests that farmers involved in the production of export crops attained lower scores compared to those cultivating food crops. Considering the restrictions imposed, it is not surprising that there was a decline in the export trade. These results can be attributed to the more complex management requirements for export-oriented agricultural businesses during a time of economic disruption. Most countries were in survival mode, and the focus was only on the food crops, making it difficult to export crops such as cotton, coffee, and flowers. A study by Barichello, (2020) indicated that, among other things, the imposition of import restrictions in different countries threatened the agricultural trade. The outbreak of COVID-19 impacted agricultural exports negatively due to the shutdown of processing facilities and the increased number of cases among workers (Mallory, 2021). Furthermore, Mao & Chen (2021) demonstrated how trade barriers and import bans made agricultural exports more vulnerable. Specific to the context of Tanzania, Saleh (2020), demonstrated that farmers who invested in export crops suffered significant consequences, especially because Tanzania exports a significant amount of its crops to neighboring East African countries. Severe lockdowns and travel restrictions were imposed by Kenya and Uganda, resulting in border closures and restrictions on cross-border movement (Tripathi et al., 2021). As a result, there were significantly fewer delivery trucks crossing Tanzania's borders with Kenya and Uganda (für Afrika, 2020).

On the other hand, less disruption was experienced by farmers who produced food crops for the domestic market. This could be because they are less reliant on international markets; thus, disruptions in the global market had a negligible impact on them (Arita et al., 2022; Tripathi et al., 2021). This can also be attributed to the low-income elasticity of food demand due to its essential nature and shipping channels that require minimal human interaction (WTO, 2020).

4.2.3. The absence of value addition in agricultural products by farmers

Value addition means improving the original state of agricultural products to create new commodities that hold increased value and desirability in the market, thereby aiming for higher returns (Evans, 2012). In this study, involvement in value addition was given a binary variable (Lack of Value Addition = 1, Presence of Value Addition = 0). The coefficient associated with the absence of value addition was negative at a significance level of 5%. This indicates that the lack of value addition in agricultural products leads to a decrease in the efficiency score. The absence of value addition could imply a reliance on raw or unprocessed agricultural products, which are often more vulnerable to logistical challenges and market disruption. Unprocessed food products require specific conditions and infrastructure for storage and transport, which have been compromised due to COVID-19 disruption. Value addition could act as a buffer against supply chain disruptions because value-added products have a longer shelf life and are better suited to withstand fluctuations in demand and supply. By extending the shelf-life of commodities (Davis, 2006), farmers could manage to minimize post-harvest losses, thereby contributing to stability during disruption. Also, value addition contributes to increased productivity and income for farmers (Kibuthu et al., 2021).

4.2.4. Capacity building through training

The coefficient associated with years of training abroad had a positive value, meaning an increase in the efficiency score at a 1% significance level. The existence of a positive coefficient sheds light on how exposure to different practices and technology improves the efficiency of farmers. The COVID-19 disruptions called for flexible practices that could withstand unforeseen disruptions. Hence, the years of training and learning from the challenges facing other countries became very important. Farmers who received training built the capacity that could aid them in adapting quickly in order to withstand the shocks and navigate the complexity of the pandemic disruption. Our findings are in line with the work of Wright et al. (2018), who emphasize that farmers' engagement in training to enhance skills and knowledge significantly contributes to the improvement of their overall efficiency. Moreover, training for capacity building equips farmers with the necessary technology and skills required to create innovative products (Davis, 2006). Further reinforcement is found in Anang & Awuni (2018) and Mariyono (2019), who demonstrated that training programs tailored for farmers can notably improve their productivity. Similarly, Xayavong et al. (2016) unveiled the pivotal role of training in increasing farm efficiency, particularly in adopting critical cropping innovations.

4.2.5. Direct Sales-To-Consumers

In the context of this study, direct sales-to-consumer marketing includes the direct sale of farm products or services to the end consumer, local grocery stores, or restaurants (Curtis et al., 2018). This approach is popular among farmers in Tanzania, where the supply and home delivery of food crops like vegetables and fruits are very common. This study aimed to explore whether the adoption of direct sales gave an advantage to farmers during the COVID-19 disruption. Direct sales-to-consumer marketing has a positive coefficient at a 5% significance level, meaning that using this marketing approach raises the probability of having higher efficiency score. The positive relationship between efficiency score and direct sales to consumers, sheds light on the advantage of this marketing practice in adapting to the challenges posed by the pandemic disruption. This could be because direct sales strategies facilitate improved engagement and interaction with consumers to ensure a more secure market and allow for rapid adjustments to meet changing consumer demands during the COVID-19 pandemic. Kapała et al. (2015) noted that direct-sales-to-consumers marketing, with its targeted approach centered on customer preferences, simplifies the agricultural product supply chain, and fosters stronger relationships between farmers and their customers. Quick adjustments and responses are also made easier by an uninterrupted flow of information, which helps farmers understand the needs of their customers and align crop production with market pricing estimates, resource availability, and target market preferences. This increases efficiency (Koreleska, 2008; Mick, 2019).

Studies have also shown that direct sales to consumers can bypass middlemen and still guarantee that goods reach their intended customers (Kádeková & Kretter, 2012; Minta & Uglis, 2018). Similarly, small and medium-sized farm owners can increase their revenue by obtaining a higher portion of the final price (Curtis et al., 2018; Wojcieszak-Zbierska & Bogusz, 2020). In contrast, traditional marketing strategies that frequently center on intermediaries and brokers have the potential to deprive farmers of their rightful earnings (Haque et al., 2022).

5. Implication and conclusion

This study has analyzed the difference in vulnerability between conventional and agritourism farmers during the COVID-19 period. It was revealed that the impact caused by economic disruptions during the pandemic was not uniform across all farmers. On average, conventional farmers outperformed agritourism farmers. Consequently, even though tourism-oriented farm diversification has huge potential, policymakers should bear in mind its vulnerability to external disruptions. The impact was diverse along the lines of involvement in the hospitality, capacity building, reliance on the international market through export, and value-addition practices. The study identified training abroad and direct sales marketing strategy as the best practices that made farmers more resilient and efficient. Contrarily, the production of export crops and lack of value-added were shown to have a negative influence.

Our results emphasize the importance of direct sales-to-consumer marketing for farmers who are looking for ways to reduce their vulnerability in the event of disruption. Direct sales to consumers ensure a smooth flow of products and align farmers with changing consumer preferences, thereby increase the agility required to thrive amidst disruptions. Further, the study calls for integrated training programs that are inclusive and adaptable across all ages to facilitate capacity building. Moreover, given the revealed vulnerability of relying on export crops, the study encourages farmers to produce a mix of export crops and food crops to reduce the risks. The study calls for players in Tanzania's agriculture sector to work toward reducing their dependence on global markets by strengthening local supply chains. Furthermore, this paper draws attention to the importance of making deliberate efforts to promote value-addition techniques among farmers to increase their resilience to market shocks.

In consideration of our findings, we can conclude that farming efficiency is profoundly influenced by factors related to market dynamics, supply chain disruptions, and adaptability to unforeseen externalities, as exemplified by the pandemic.

Finally, while conventional farmers generally outperformed agritourism farmers on average, agritourism as a subsector exhibited stronger performance compared to conventional tourism such as wildlife safari, mountain climbing and Island destinations. Unlike conventional tourism, agritourism diversification serves as a protective measure against disruptions such as travel bans, enabling farmers to sustain income streams through the sale of farm products. The unique blend of physical products and hospitality services in agritourism contributed to a more income stability, showcasing its risk aversion capabilities during crises like the COVID-19 pandemic. These observations suggest that agritourism holds promise for mitigating crisis impacts by providing diversified income sources and strengthening resilience against economic shocks. However, further research is needed to explore the long-term sustainability and scalability of agritourism strategies in response to various crisis scenarios.

6. Limitation and future studies

Since in Tanzania the agritourism subsector is still in its infancy, the present study focuses only on efficiency and factors influencing efficiency in the early stages of agritourism projects. Although we were able to reflect the efficiency levels, the situation may differ during the maturity stage, when the agritourism subsector is already well established. The early developmental stage of agritourism, coupled with the COVID-19 context, may pose potential limitations impacting the generalizability of these results. To gain a better understanding, further research is required once agritourism is well established and outside the context of the COVID-19 pandemic. Such research would shed light on efficiency and related factors in non-crisis scenarios, offering valuable and more widely generalizable insights. Additionally, a research on the broader context of sustainability, emphasizing the importance of considering environmental and community impacts in agritourism development would offer valuable and more widely generalizable insights.

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Statement of Author Contributions
IK: Conceptualization, Methodology, Data collection and Analysis, Writing - Review & Editing; YO: Validation of the research design, validation of the results as well as reviewing and editing the manuscript.

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Research Paper

Exploring the Viability of Utilizing Agricultural and Rural Areas for Tourism: A Comparative Analysis of Farming Between Conventional and Agritourism Farms during the COVID-19 pandemic

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Abstract: This study compares the performance of conventional and agritourism farming to investigate how the COVID-19 epidemic has affected agricultural efficiency. The study was carried out in Sub-Saharan Africa, particularly in Tanzania, due to a comparatively high concentration of agritourism and conventional farmers. Regression analysis and the slack-based measure data envelopment analysis model (SBM-DEA) are used in this study to assess farming efficiency and identify the critical variables influencing the productivity of conventional and agritourism farmers. The application of the comparative approach is what sets this paper apart, as most researchers tend to examine conventional farmers and agritourism farmers separately leading to a noticeable methodological gap. The results reveal a significant efficiency gap, where conventional farmers outperformed agritourism farmers. This result shows how vulnerable agritourism farming is to external disruptions exemplified by COVID-19-related disruptions. Moreover, the study identifies the positive influence of training and direct sales-to-consumers on efficiency, while recognizing the negative influence of lack of value addition and production of export crops. These insights are important for designing targeted strategies to ensure a sustainable recovery post-COVID-19.

Keywords:

1. Agritourism
2. Efficiency
3. SBM-DEA Model
4. Comparative Analysis
5. COVID-19

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1. Introduction

Agriculture and tourism are two critical sectors for socioeconomic development in Sub-Saharan countries like Tanzania as they generate a huge portion of employment opportunities, income, and foreign exchange earnings. In Tanzania, around 65% of the workforce is employed in the agriculture sector, which contributes 25% of the GDP (NBS, 2020). Similarly, Tanzania is a popular tourist destination, well-known for its wildlife, islands, and cultural attractions. The tourism sector creates employment in various areas, such as hotels, tour companies, restaurants, and related businesses. In 2019, the sector contributed around 17.5% to the nation's GDP and employed 11.1% of the workforce (UNWTO, 2020). Various studies suggest that the tourism industry holds the potential to reduce poverty and foster economic development in developing countries (Binns and Nel, 2002; Li et al., 2018; Liu and Wu, 2019; UNCTAD, 2004). In Tanzania, the tourism sector is used to reduce poverty through job creation and the market for traditional products (Odhiambo, 2011).

Now let’s turn our focus to tourism-oriented diversification in agriculture. By combining the two sectors, agritourism has emerged as a unique form of diversification that has a positive impact on both ends. It helps farmers preserve and safeguard their rural environment while providing tourists with the chance to experience and enjoy a rural lifestyle (Sonnino, 2004). Agritourism also offers farmers a chance to improve their standard of living, opens up a new revenue stream, and creates a unique combination of tourism and agriculture-related activities. Agritourism can also offer a different market and an alternative distribution channel for farm products (Valdivia & Barbieri, 2014).

Tourism-oriented diversification has been recognized as an effective way to accelerate socioeconomic development in rural areas (Ohe & Kurihara, 2013). Additionally, it offers financial incentives to the local government and community to protect tourism resources, preserve traditional farming practices, and support a sustainable economy.

This type of diversification has resulted in the coexistence of two separate subsectors in Tanzania: agritourism and traditional farming. This study will broadly describe conventional farmers as those who just engage in traditional farming practices, without offering tourism-related experiences to visitors. And agritourism farmers will be broadly defined as individuals who own and operate farms or agricultural businesses actively providing touristic experiences. The agritourism sub-sector remains in its early stages of development and involves activities such as farm tours, agroforestry, and culinary services. In times of economic distress, such as a poor harvest or low prices, diversification strategies have been suggested to increase and stabilize farmers' incomes or to best supplement farm incomes (Kim et al., 2019). However, just as conventional farming is susceptible to external shocks like market fluctuations and climate change (Shemdoe, 2011), agritourism farming is also not immune to such shocks.

Both the conventional and agritourism subsectors experienced unparalleled disruption following the onset of the COVID-19 epidemic. As COVID-19 rapidly spread, many nations implemented strict measures to safeguard public health (Weible et al., 2020). These responses profoundly shocked the global economy (Ceylan, 2020), particularly affecting developing nations. As a result, the outbreak added huge damage to the already-vulnerable agritourism and the conventional farming subsector. While tourism-oriented diversification in the agricultural sector has been more popular recently in Sub-Saharan Africa (SSA), little research has been done on its economic resilience and effectiveness in times of crisis. The goal of the present research is to evaluate how the pandemic has differentially affected agritourism and traditional farming, with an emphasis on comparing farming productivity. The paper will also explore factors influencing the efficiency of the two groups of farmers during disruptions. Finally, the paper will recommend some insights on sustainable recovery for farmers and agricultural systems from periods of disruptions. Two questions are proposed:

- RQ1: Is there a significant efficiency gap between agritourism and conventional farmers during the pandemic?
- RQ2: What are the key factors that affect efficiency of both conventional and agritourism farmers?

The capacity of a farm to produce the highest level of output with the lowest amount of feasible inputs will be the definition of farming efficiency used in this paper (Chimai, 2011). Therefore, given the quantity of input utilized, efficient farms are those that are able to generate the maximum amount of revenue. In other words, an efficient farm uses its resources effectively to get the most value and to produce revenue while minimizing waste; conversely, inefficient farms are those that fail to utilize their inputs effectively to produce the same level of output compared to the most efficient farms in the sample (Odhiambo et al., 2004). Inefficient farms may needlessly require a higher level of inputs than necessary to produce the outputs they generate, indicating that they have not adapted well to the pandemic disruptions.

The results of this study can provide valuable insights for stakeholders aiming for a sustainable post-pandemic recovery for farmers and agricultural systems across Sub-Saharan Africa (Duguma et al., 2021; Gordon, 2020). Similarly, conflicts of interest between players in the agritourism subsector are an inevitable occurrence (Wang & Yotsumoto, 2019). Thus, the research findings may help policymakers in arriving at well-informed choices that yield mutual benefits among all stakeholders, particularly as they strive to recover from the COVID-19 pandemic. Finally, knowing what influences efficiency will equip farmers with some insights to withstand future economic disruptions.

The sections of this paper are organized as follows. Section 2 reviews Tanzania's agriculture and tourism sectors, the emergence of tourism-oriented diversification, the impact of COVID-19, and the implementation of data envelopment analysis. Section 3 covers the study's methodology and background. Section 4 presents and discusses the results. Section 5 lays out the conclusion, recommendations, and further research. Section 6 elucidates the study's limitations.

2. Literature review

2.1. An overview of Tanzania's agriculture and tourism sectors

Tanzania is a country with abundant resources for both agriculture and tourism. Agriculture in Tanzania is dominated by conventional farmers involved in cultivation of staple crops, livestock keeping, and subsistence farming (Kimaro & Hieronimo, 2014; Tanzania invests, 2020). Tanzania is also one of the most popular tourist destinations in sub-Saharan Africa. According to the World Tourism Organization, 2021, In 2019, Tanzania held a significant share of international tourism receipts in the region, ranking behind South Africa as the leader in terms of international tourism receipts. Tanzania's economy is heavily dependent on the agricultural sector (Mwonge & Naho, 2021); But, the sector faces challenges like low productivity, price fluctuations, and limited market access, preventing it from realizing its full potential (World Bank, 2018). Moreover, Shemdoe (2011) mentioned climate variability, such as irregular rain patterns, periodic droughts, and flooding, as huge challenges in the agriculture sector. Similarly, the tourism sector faces its own set of challenges, including the seasonality of its operations, competition from other destinations, and a lack of diversification (OECD, 2014). Other studies argued that the leakage of tourism revenue is one of the biggest challenges (Boz, 2011; UNEPTIE, 2007). Tourism leakage occurs when revenue fails to remain or circulate within the host destination's economy because it's spent on imported goods and services, accommodations in foreign-owned hotels, and external payments such as travel agent commissions, tour operator profits, and revenue from foreign airlines (Boz, 2011; UNEPTIE, 2007). The challenges above emphasize the necessity for tourism-oriented diversification as a strategy to mitigate the issues in Sub-Saharan Africa, as discussed in the next section.

2.2. The emergence of tourism-oriented diversification

Agritourism has been more popular in recent years as a way for the agricultural sector to diversify. It gives farmers an opportunity to make extra revenue and broaden their horizons by engaging in activities beyond conventional farming practices (Lyon & Canovi, 2019). Along with helping farmers preserve agricultural viability and diversify rural economies, it offers visitors a unique chance to enjoy traditional rural hospitality, access to nature, and cultural experiences (Yang, 2012). Additionally, by guaranteeing that even marginalized rural populations actively participate in and profit from tourism, agritourism might play a vital role in establishing more inclusive and sustainable socio-economic growth in rural areas. A tourism-related poverty reduction plan has to include policies that promote quick and sustainable economic growth (Karunarathne et al., 2019). In principle, the exclusion of the local community hinders sustainability. Lastly, due to high competition in the tourism sector, countries are increasingly aiming to leverage and promote their natural resources as a strategic approach to attract more tourists (Plourde, 2003). This is achieved by strategically expanding and diversifying the range of attractions and services within a destination to appeal to a broader spectrum of tourists; these new tourism products, experiences, and services cater to different demographics of tourists. Consequently, if Sub-Saharan African countries like Tanzania fail to capitalize on this opportunity, they might find themselves in a disadvantaged position.

2.3. Economic susceptibility in the agriculture sector and the impact of covid-19

Tanzania's government imposed localized lockdowns around the country in response to the surge in COVID-19 cases that began in 2020 (Economic Commission for Africa, 2020). Restrictions on movement delayed time-sensitive tasks, which had an effect on the amount and quality of agricultural output. Disruptions in labor mobility, supply chains, and the availability of crucial farming inputs were the causes of the impacts (Ayanlade & Radeny, 2020; Wang et al., 2022). Due to the unforeseen labor supply disruption caused by the COVID-19 pandemic, it was difficult to fill production roles, which increased costs and decreased productivity (Wang et al., 2022). This added to the vulnerability associated with external shocks, such as climate change and market fluctuations. Similarly, amid its successful establishment, the trajectory of tourism-oriented diversification encountered an unforeseen disruption by COVID-19, inflicting a profound and devastating impact. The substantial negative consequences of movement restrictions on non-essential sectors, particularly the service and tourist industries, were brought to light by Arita et al. (2022).

2.4. Unexplored areas and gaps in the existing literature

Considering that agricultural systems and crop production in Sub-Saharan Africa are diverse and heterogeneous by nature (de Graaff et al., 2011), the impact of the COVID-19 disruption is unlikely to be uniform across the board (Ayanlade and Radeny, 2020). Different farmers undoubtedly have different capacities to react, adjust, and absorb the shocks from the disruption depending on aspects including crop types, agritourism engagement, age of farmers, value addition strategies, reliance on foreign markets, and training. Béné (2020) revealed that the ability of farmers to address the challenges posed by COVID-19 is deeply influenced by context, including factors like country-specific restrictions, socio-economic conditions, and integration within supply chains.

Despite the importance of tourism-oriented diversification in the agricultural sector, the empirical evidence of the impacts of COVID-19 on agricultural systems across Sub-Saharan Africa is notably limited. Previous research has consistently pointed to the need for a thorough investigation and comprehension of the effects of the COVID-19 disruption on different farmer groups (Cattivelli & Rusciano 2020; Darnhofer 2020; Gunther 2020; Henry 2020). Furthermore, existing literature has predominantly focused on conventional farming, ignoring the emerging sub-sector of agritourism; therefore, there is a contextual gap resulting from the prior studies' failure to consider the agritourism subsector. Lastly, as far as the authors know, there is a noticeable methodological gap involving the oversight of comparative analysis between the two categories of farmers in Sub-Sahara Africa, as most researchers tend to examine conventional farmers and agritourism farmers separately. The application of the comparative approach is what sets this paper apart. This study aims to bring a fresh perspective and lay the foundation for future researchers to examine variations in the impacts experienced by different sub-groups within a broader collective during disruptions. The use of data envelope analysis (DEA), which is not yet widely applied in the domains of agriculture and agritourism, would be another noteworthy contribution.

2.5. Data envelopment analysis (DEA) and DEA extensions

Data envelopment analysis (DEA) is a non-parametric approach used for the estimation of the efficiency of the decision-making units of companies, businesses, or farms (Cooper et al., 2007). It is employed to provide insights about how best to allocate resources to increase efficiency. For its implementation, the DEA approach only requires data on quantities produced and inputs used (Coelli et al., 2005). DEA analysis is appropriate for assessing farm efficiency in the context of this study as it does not need assumptions about farm production technology, can be used at any aggregate level, including the farm level, and allows multiple outputs and inputs (Perrigot et al., 2009). Two basic DEA models are the CCR (Charnes-Cooper-Rhodes), which assumes a constant return to scale, and the BCC (Banker-Charnes-Cooper), which assumes a variable return to scale (Cooper et al., 2007). Due to its radial design, which emphasizes reducing inputs and increasing outputs, these models, although being frequently used, have several drawbacks. As a result, non-radial models such as SBM models were developed. The Slack-Based Measure (SBM) of Efficiency (Tone, 2001) aims at maximizing the sum of the inputs and outputs slacks for each decision making unit (DMU) used in a sample. This model has an advantage since it considers unutilized resources in the evaluation of efficiency (Ohe, 2022).

Now let’s turn our attention to DEA extensions. After getting the results of the DEA analysis, most researchers implement additional steps using the efficiency scores obtained for further analysis. The most used method is regression analysis, particularly the tobit regression model. The use of the Ordinary Least Square (OLS) model can give biased results because of the possibility of including zero values obtained in DEA analysis (Chang et al., 2022). To avoid biased results, the tobit model is preferred for exploring the socio-economic variables that are affecting the obtained efficiency scores (Gabdo et al.2018; Hassen et al. 2017).

3. Methods

A cross-sectional survey was carried out between September and November of 2022. The Arusha and Mwanza regions in Tanzania were selected due to the high concentration of agriculture and tourism activities. A single-stage sampling procedure was used for the selection of the respondents for interviews and the completion of the questionnaires. The primary respondents were farmers, but government officials were also included for additional information. Farmers were divided into two groups, namely 25 conventional farmers and 20 agritourism farmers. A random sampling technique was adapted to reduce bias and improve the generalizability of our findings (Keppel and Wickens, 2003). Ensuring that each member of the defined groups had an equal probability of being selected required the use of this technique.

Data on inputs utilized and outputs generated was gathered from both farmer groups. Revenue was the output variable, while the input factors were land size, labor cost, other material cost, and capital cost. This comprehensive approach ensured that the survey instrument included all relevant components of farming operations, hence strengthened the dataset.

The study employed a two-stage method for data analysis, whereby the input used and output generated by each farm are used as data in the first stage to estimate efficiency using a DEA model. And in the second stage, the efficiency scores of the DEA analysis were used as a dependent variable in a regression model. Since this paper touches on the topic of agritourism, which is a form of farm diversification, the Slack-Based Measure (SBM) was adopted. The SBM model is more adequate for farm diversification activities because excess inputs or shortfalls in outputs can be expected (Ohe, 2022). Furthermore, a bilateral model was used since two sets of inputs and outputs are being considered simultaneously in this study to assess the effectiveness of DMUs. The model assumed a constant return to scale (CRS) because the farms included in the sample had narrow variation and all decision-making units (DMUs) were at optimal scale (Javed et al., 2010). Additionally, the output-oriented super SBM model was used for cross-validation of the results of the SBM model, as it allows for a more robust assessment of the model's performance. In the output-oriented DEA model, the inputs are held fixed while aiming to maximize the outputs produced by the DMUs (Charnes et al., 1978; Farrel, 1957).

Because the analysis of efficiency scores is not enough to explain the factors that cause variation in efficiency, the study used the efficiency scores as dependent variables in a regression analysis for the determination of the factors influencing efficiency (Bojnec & Latruffe, 2008; Coelli et al., 2005). Since the DEA efficiency scores are bounded between 0 to 1, they are not normally distributed (Dhungana et al., 2004). For this reason, normal regression analysis is not suitable as the variables are partly continuous and partly discrete (Wooldridge, 2010). Hence, the tobit regression model was preferred (Cooper, 1999). In previous studies by Al-Mezeini et al. (2020), Dhungana et al. (2004), and Li et al. (2018), tobit analysis was applied after efficiency evaluation to detect the factors that affect the efficiencies. In our study, the variables that were anticipated to influence efficiency included age of farmers, level of education, number of crops produced, years of training, production of export crops, direct sales to consumers strategy, and value-added practices.

4. Results and Discussion

4.1. Comparative efficiency of farmers

Using data envelope analysis (DEA), farms were assessed to determine whether they were efficient or inefficient. This categorization is based on the ability of the farm to convert inputs into outputs relative to other farms included in the sample. Table 1 summarizes the variables that were used to estimate the model.

Table 1. Descriptive statistics of the Input and output variable used for DEA model

	Inputs				Output
Item	Land size (ha)	Material Cost (USD)	Labor Costs (USD)	Capital Cost (USD)	Revenue (USD)
Max	10	2200	5500	10000	12000
Min	0.5	100	200	400	500
Mean	4.6	963.3	2259.4	4153.3	5082.2
SD	2.8	660.6	1758.3	3059.8	3469.6

Note: DEA: data envelopment analysis; Source: Field survey, 2022.

The results of the bilateral SBM model show a significant efficiency gap, where conventional farmers outperform agritourism farmers. The same results were obtained by the output-oriented Super SBM model, thereby indicating a better fit of the data. The graphical representation of the relative efficiency is shown in Figure 1. Conventional farmers may have achieved greater efficiency scores because they primarily focused on producing food crops and did not rely much on the global market. According to Torero (2020) and Frelat et al. (2016), conventional farmers in Sub-Saharan Africa are largely responsible for growing a significant amount of food crops. During the COVID-19 pandemic, trade in food products experienced comparatively less disruption. This resilience in demand for food products is rooted in their essential nature for survival (Chenarides et al., 2021). Actually, as people stocked up and cooked more at home, there was an increase in demand for staple food crops like rice and maize. This increased demand pushed prices higher, increased conventional farmers' revenues, and made it easier for them to improve their efficiency compared to their counterparts. Conversely, agritourism farmers rely on revenue from both hospitality and agricultural production; And the hospitality part of the agritourism operation were heavily affected by COVID-19 restrictions leading to less efficiency. Moreover, implemented measures for maintaining health and safety protocols to keep staffs and visitors safe added to the cost of operation (Wang et al., 2022). Wang et al. (2022) compared tourism and non-tourism sector by examining the effects on output, basic price, and investment; The study found that there was a decrease in the prices of tourism goods while the prices of non-tourism goods increased owing to a demand shock. Additionally, the study found that the reduction in output in the tourism-related sector was substantially higher than that in non-tourism sectors like agriculture sector.

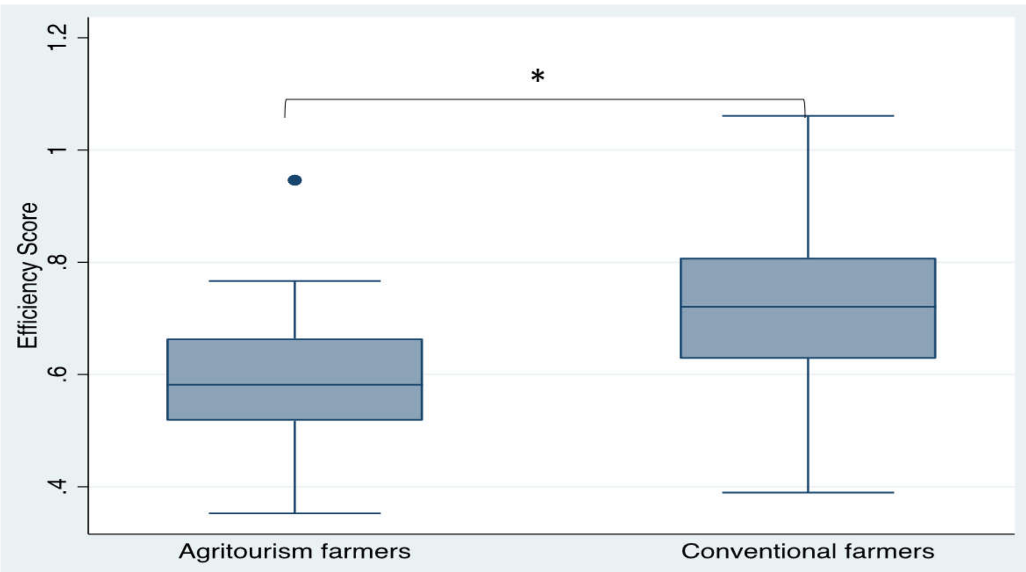

Figure 1. Boxplot of efficiency score by groups (Bilateral SBM-C)

Note: DEA: data envelopment analysis; SBM: Slack-based measure; (*) indicates 5% significance; Source: Field survey, 2022.

Additionally, due to low demand during the pandemic, harvest festivals and seasonal crop tours had to be canceled, which significantly decreased revenues. This resulted from either travel bans enforced by the government or travelers choosing to forego travel out of fear of catching the virus (Wang et al., 2022). The fact that agritourism farmers' activities did not fall under a category of important businesses made matters worse by limiting their access to government support. This might account for the comparatively lower efficiency shown, especially among those who were still in the pioneer stage.

The boxplots indicate that conventional farmers have a higher median efficiency score but a wider interquartile range (IQR) than conventional farmers, suggesting that conventional farmers are generally more efficient but have more variability in performance than agritourism farmers. The reason behind the disparity in efficiency for conventional farmers could be attributed to several factors: Firstly, some conventional farmers are involved in the cultivation of food crops that are not typical for domestic consumption. Products not directly tied to food consumption at home often show higher sensitivity to economic disruptions (Binkley & Liu, 2019). Other conventional farmers were impacted because they produced relatively expensive crops. This is because people became reluctant to purchase some expensive crop because of decreased income and financial uncertainty. Wang et al. (2022), showed that people focused on increasing savings and reducing consumption.

Further, variability in the efficiency score may also result from some conventional farmers' use of hired labor, particularly those with farms that are relatively larger than those of their peers. Harvesting, weeding, and planting were among the crucial farm management tasks that were delayed due to a manpower shortage. Meuwissen et al. (2020) found that smaller farms which rely mostly on family labor exhibited higher resilience than bigger farms that use hired labor. Lastly, some conventional farmers produced high-value perishable crops; as a result, supply chain disruption caused more severe post-harvest losses. When Varshney & Meenakshi (2023) analyzed the effects of COVID-19 on perishable and non-perishable goods, they found that the effects varied according on the type of goods. Food products were the most negatively impacted by trade restrictions because they were especially vulnerable to disruptions in transportation (WTO, 2020).

4.2. Factors influencing efficiency

This section presents a comprehensive analysis of several factors, including age, the number of crops, involvement in export crops, years of training abroad, direct sales to consumers, and involvement in value-addition. The independent variables that affect farmers' efficiency are shown in Table 2. The output indicates that the tobit regression model is significant at the 0.000 level. The LR chi2 value of 96.29 is significant at the 5% level (prob > chi2 = 0.0000), and a higher log-likelihood of 65.744 indicates that the model is a good fit for the data.

Table 2. The results of tobit regression

Score	Coefficient	t Static
Age (years)	-0.0051***	-3.74
Number of crops produced	7.088e-06	0.00
Years of training abroad	0.0393**	2.59
Export crops (export crop =1, food crops =0)	-0.0401*	-2.24
Direct sales to consumers (direct sales to consumer =1, Other	0.0761*	2.25
Value-added products (without = 1, with = 0)	-0.0454*	-2.30
Constant	0.8134***	9.99
LR Chi-Squire	96.29*	

Note: 1) ***, **, and * indicates 0.1% significance, 1% significance and 5% significance, respectively; Source: Field survey, 2022.

4.2.1. Age of the farmers

At a statistically significant level of 0.1%, the coefficient for the age of farmers in years showed a negative value, suggesting that an increasing in age is linked to a decrease in efficiency score. This may be related to the degree of adaptation and flexibility exhibited by farmers across various age groups. During Covid-19 pandemic, a quick adjustment was required due to supply chain disruption, changing market needs, and changed customer behavior. Hence, it became obvious that flexibility and adaptability were important. Unfortunately, older farmers were less flexible to the adjustments, which could have lowered their efficiency. Although useful, elder farmers' experience may have created a degree of rigidity that made it more difficult for them to face the challenges brought on by the COVID-19 pandemic. This observation aligns with Weeden (2008) and Fried & Tauer (2016), who observed a comparable negative correlation between farmers' age and efficiency. It's necessary to understand that age's impact extends beyond production to affect marketing efforts. To illustrate, Kamdem (2012), examining the relationship between farmers' age and marketing efficiency, found a negative effect. Contrastingly, Ohe (2020) observed that the age of the farmers had a positive relationship to business performance because the elder farmers could take good care of the visitors in tourism-oriented diversification. Other studies, indicated a different observation, where efficiency slightly increases with age before eventually decreasing (Lordkipanidze & Tauer, 2000; Tauer,1995).

4.2.2. Production of export crops and food crops

The coefficient associated with the production of export crops was negative, indicating a significant decrease in the efficiency score when engaged in the production of export crops at the 5% significance level. This suggests that farmers involved in the production of export crops attained lower scores compared to those cultivating food crops. Considering the restrictions imposed, it is not surprising that there was a decline in the export trade. These results can be attributed to the more complex management requirements for export-oriented agricultural businesses during a time of economic disruption. Most countries were in survival mode, and the focus was only on the food crops, making it difficult to export crops such as cotton, coffee, and flowers. A study by Barichello, (2020) indicated that, among other things, the imposition of import restrictions in different countries threatened the agricultural trade. The outbreak of COVID-19 impacted agricultural exports negatively due to the shutdown of processing facilities and the increased number of cases among workers (Mallory, 2021). Furthermore, Mao & Chen (2021) demonstrated how trade barriers and import bans made agricultural exports more vulnerable. Specific to the context of Tanzania, Saleh (2020), demonstrated that farmers who invested in export crops suffered significant consequences, especially because Tanzania exports a significant amount of its crops to neighboring East African countries. Severe lockdowns and travel restrictions were imposed by Kenya and Uganda, resulting in border closures and restrictions on cross-border movement (Tripathi et al., 2021). As a result, there were significantly fewer delivery trucks crossing Tanzania's borders with Kenya and Uganda (für Afrika, 2020).

On the other hand, less disruption was experienced by farmers who produced food crops for the domestic market. This could be because they are less reliant on international markets; thus, disruptions in the global market had a negligible impact on them (Arita et al., 2022; Tripathi et al., 2021). This can also be attributed to the low-income elasticity of food demand due to its essential nature and shipping channels that require minimal human interaction (WTO, 2020).

4.2.3. The absence of value addition in agricultural products by farmers

Value addition means improving the original state of agricultural products to create new commodities that hold increased value and desirability in the market, thereby aiming for higher returns (Evans, 2012). In this study, involvement in value addition was given a binary variable (Lack of Value Addition = 1, Presence of Value Addition = 0). The coefficient associated with the absence of value addition was negative at a significance level of 5%. This indicates that the lack of value addition in agricultural products leads to a decrease in the efficiency score. The absence of value addition could imply a reliance on raw or unprocessed agricultural products, which are often more vulnerable to logistical challenges and market disruption. Unprocessed food products require specific conditions and infrastructure for storage and transport, which have been compromised due to COVID-19 disruption. Value addition could act as a buffer against supply chain disruptions because value-added products have a longer shelf life and are better suited to withstand fluctuations in demand and supply. By extending the shelf-life of commodities (Davis, 2006), farmers could manage to minimize post-harvest losses, thereby contributing to stability during disruption. Also, value addition contributes to increased productivity and income for farmers (Kibuthu et al., 2021).

4.2.4. Capacity building through training

The coefficient associated with years of training abroad had a positive value, meaning an increase in the efficiency score at a 1% significance level. The existence of a positive coefficient sheds light on how exposure to different practices and technology improves the efficiency of farmers. The COVID-19 disruptions called for flexible practices that could withstand unforeseen disruptions. Hence, the years of training and learning from the challenges facing other countries became very important. Farmers who received training built the capacity that could aid them in adapting quickly in order to withstand the shocks and navigate the complexity of the pandemic disruption. Our findings are in line with the work of Wright et al. (2018), who emphasize that farmers' engagement in training to enhance skills and knowledge significantly contributes to the improvement of their overall efficiency. Moreover, training for capacity building equips farmers with the necessary technology and skills required to create innovative products (Davis, 2006). Further reinforcement is found in Anang & Awuni (2018) and Mariyono (2019), who demonstrated that training programs tailored for farmers can notably improve their productivity. Similarly, Xayavong et al. (2016) unveiled the pivotal role of training in increasing farm efficiency, particularly in adopting critical cropping innovations.

4.2.5. Direct Sales-To-Consumers

In the context of this study, direct sales-to-consumer marketing includes the direct sale of farm products or services to the end consumer, local grocery stores, or restaurants (Curtis et al., 2018). This approach is popular among farmers in Tanzania, where the supply and home delivery of food crops like vegetables and fruits are very common. This study aimed to explore whether the adoption of direct sales gave an advantage to farmers during the COVID-19 disruption. Direct sales-to-consumer marketing has a positive coefficient at a 5% significance level, meaning that using this marketing approach raises the probability of having higher efficiency score. The positive relationship between efficiency score and direct sales to consumers, sheds light on the advantage of this marketing practice in adapting to the challenges posed by the pandemic disruption. This could be because direct sales strategies facilitate improved engagement and interaction with consumers to ensure a more secure market and allow for rapid adjustments to meet changing consumer demands during the COVID-19 pandemic. Kapała et al. (2015) noted that direct-sales-to-consumers marketing, with its targeted approach centered on customer preferences, simplifies the agricultural product supply chain, and fosters stronger relationships between farmers and their customers. Quick adjustments and responses are also made easier by an uninterrupted flow of information, which helps farmers understand the needs of their customers and align crop production with market pricing estimates, resource availability, and target market preferences. This increases efficiency (Koreleska, 2008; Mick, 2019).

Studies have also shown that direct sales to consumers can bypass middlemen and still guarantee that goods reach their intended customers (Kádeková & Kretter, 2012; Minta & Uglis, 2018). Similarly, small and medium-sized farm owners can increase their revenue by obtaining a higher portion of the final price (Curtis et al., 2018; Wojcieszak-Zbierska & Bogusz, 2020). In contrast, traditional marketing strategies that frequently center on intermediaries and brokers have the potential to deprive farmers of their rightful earnings (Haque et al., 2022).

5. Implication and conclusion

This study has analyzed the difference in vulnerability between conventional and agritourism farmers during the COVID-19 period. It was revealed that the impact caused by economic disruptions during the pandemic was not uniform across all farmers. On average, conventional farmers outperformed agritourism farmers. Consequently, even though tourism-oriented farm diversification has huge potential, policymakers should bear in mind its vulnerability to external disruptions. The impact was diverse along the lines of involvement in the hospitality, capacity building, reliance on the international market through export, and value-addition practices. The study identified training abroad and direct sales marketing strategy as the best practices that made farmers more resilient and efficient. Contrarily, the production of export crops and lack of value-added were shown to have a negative influence.

Our results emphasize the importance of direct sales-to-consumer marketing for farmers who are looking for ways to reduce their vulnerability in the event of disruption. Direct sales to consumers ensure a smooth flow of products and align farmers with changing consumer preferences, thereby increase the agility required to thrive amidst disruptions. Further, the study calls for integrated training programs that are inclusive and adaptable across all ages to facilitate capacity building. Moreover, given the revealed vulnerability of relying on export crops, the study encourages farmers to produce a mix of export crops and food crops to reduce the risks. The study calls for players in Tanzania's agriculture sector to work toward reducing their dependence on global markets by strengthening local supply chains. Furthermore, this paper draws attention to the importance of making deliberate efforts to promote value-addition techniques among farmers to increase their resilience to market shocks.

In consideration of our findings, we can conclude that farming efficiency is profoundly influenced by factors related to market dynamics, supply chain disruptions, and adaptability to unforeseen externalities, as exemplified by the pandemic.

Finally, while conventional farmers generally outperformed agritourism farmers on average, agritourism as a subsector exhibited stronger performance compared to conventional tourism such as wildlife safari, mountain climbing and Island destinations. Unlike conventional tourism, agritourism diversification serves as a protective measure against disruptions such as travel bans, enabling farmers to sustain income streams through the sale of farm products. The unique blend of physical products and hospitality services in agritourism contributed to a more income stability, showcasing its risk aversion capabilities during crises like the COVID-19 pandemic. These observations suggest that agritourism holds promise for mitigating crisis impacts by providing diversified income sources and strengthening resilience against economic shocks. However, further research is needed to explore the long-term sustainability and scalability of agritourism strategies in response to various crisis scenarios.

6. Limitation and future studies

Since in Tanzania the agritourism subsector is still in its infancy, the present study focuses only on efficiency and factors influencing efficiency in the early stages of agritourism projects. Although we were able to reflect the efficiency levels, the situation may differ during the maturity stage, when the agritourism subsector is already well established. The early developmental stage of agritourism, coupled with the COVID-19 context, may pose potential limitations impacting the generalizability of these results. To gain a better understanding, further research is required once agritourism is well established and outside the context of the COVID-19 pandemic. Such research would shed light on efficiency and related factors in non-crisis scenarios, offering valuable and more widely generalizable insights. Additionally, a research on the broader context of sustainability, emphasizing the importance of considering environmental and community impacts in agritourism development would offer valuable and more widely generalizable insights.

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The author(s) declare no potential conflict of interest.

Statement of Author Contributions
IK: Conceptualization, Methodology, Data collection and Analysis, Writing - Review & Editing; YO: Validation of the research design, validation of the results as well as reviewing and editing the manuscript.

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Research Paper

The Influencing of Consumer Aspirations on Food Choice, Sourcing and Consumption Among Low-Income Households of eThekwini Municipality: A Pilot Study

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Abstract: Unhealthy foods, availed through food retail supermarkets, restaurant franchises, and the local street food market, have become everyday foods for the average South African. Reliance on unhealthy food results in high incidence of non-communicable diseases, which necessitate a transition towards healthy diets produced from sustainable healthy food systems. This study sought to understand factors influencing food choice, sourcing, and resultant food consumption behaviour among low-income households of eThekwini Municipality, South Africa. The study used the photovoice method to collect primary data and the inductive thematic approach to analyse the data. Results reveal that consumer food choice, sourcing, and consumption are influenced by deeply rooted aspirations for a superior lifestyle which drives perceptions about socially acceptable foods. These aspirations not only define and perpetuate an unhealthy diet but have the potential to suppress efforts towards development of sustainable healthy food systems. This study opens discourses on consumer aspirations in relation to food choice, sourcing, and consumption behaviour, which are critical to policy and programme development in promoting healthy diets among low-income households of South Africa.

Keywords:

1. Consumer aspirations
2. Consumption behaviour
3. Food choice
4. Sustainable healthy food systems
5. Low-income households

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1. Introduction

Literature (Otterbach et al., 2021; Bodirsky et al., 2020; Mbogori & Mucherah, 2019; Battersby, 2017) highlights a nutrition transition, driven by big multi-national corporations that sustain accessibility, availability, affordability, and convenience of food consumption. Food production processes feeding into these corporations are natural resource intensive and produce waste that is toxic to the environment and humanity (Bodirsky et al., 2020; Willett et al., 2019; IPES-Food, 2017). Literature highlights alternative food systems which chart a way towards healthy diets produced from sustainable food systems (Cacau et al., 2021; Bodirsky et al., 2020; Willett et al., 2019).

In South Africa, policy responses have been directed at promoting nutrition and health outcomes using tax instruments such as zero-rating value added tax on staple and healthy foods; nutrient fortification; increasing sugar tax; and salt reduction regulation (Haggblade et al., 2016, p. 227; Republic of South Africa, 2016). Other policy measures include nutrition and food security through the Integrated Nutrition Programme implemented at an individual and household level; and in schools under the National School Nutrition Programme (Mbogori & Mucherah, 2019; Department of Basic Education, undated). Lastly, Social Assistance and Social Relief of Distress are among other policy measures aimed at reducing household food insecurity and hunger (Boatemaa et al., 2018).

Research has focused on nutrient fortification through bio-fortification (Zuma et al., 2018; Govender, 2018) and micro-food production (Khumalo & Sibanda, 2019; Roberts & Shackleton, 2018; Olivier & Heinecken, 2017; Mansfield et al., 2015). Other research has focused on food sourcing (Crush et al., 2018; Haysom et al., 2017); and commercialisation and consumption of underutilised foods (Mabhaudhi et al., 2017; Modi & Mabhaudhi, 2016). Recommendations for systematic and holistic approaches that address food and nutrition challenges are also evident. One such recommendation is to integrate behaviour change, education, and awareness into sustainable diet change strategies (Akinola et al., 2020; Siwela et al., 2020; Boatemaa et al., 2018; Govender, 2018). This paper delves into factors influencing food choice, sourcing, and resultant food consumption behaviour among low-income households of eThekwini Municipality, South Africa. The questions we ask are: 1) What is healthy food? 2) Where is healthy food sourced and how has food choice, sourcing, and consumption (FCSC) changed over time? 3) What factors influence FCSC?

2. Study Area and Methods

The study was conducted in the eThekwini Municipality of Durban, South Africa. eThekwini Municipality is home to 3.7 million people (eThekwini Municipality, 2019) living in 1,125,765 households (Department of Cooperative Governance and Traditional Affairs-CoGTA, 2020). It has high levels of poverty (41% living below South Africa's Lower Poverty Line), unemployment (18.7%) and informality (26% live in informal settlements) (CoGTA, 2020; eThekwini Municipality, 2017). The Municipality comprises an urban core and a large peri-urban and rural periphery. About 43% of the municipal area is under the dual governance system of the eThekwini Municipality and the Traditional Authority (Ingonyama Trust Board) governing Ingonyama Trust land (Sims et al., 2018).

This study presents two contexts of low-income urban living:

- Rural and peri-urban settlements include Maphephetha (Rural area M), Mzinyathi (Peri-urban M) and Ngcolosi (Peri-urban N) which are governed by the Ingonyama Trust Board but serviced by eThekwini Municipality.
- Informal and Reconstruction and Development Programme (RDP) Housing settlements include Quarry Road West (Informal settlement QRW) and Thandanani (Informal settlement T); and Hammonds Farm (RDP HF) and Congo (RDP C) are governed and serviced by eThekwini Municipality. Immigrants from rural areas settle in informal settlements and over time are relocated to formal Government-subsidised housing (so called RDP). (Appendix 1a).

2.1. Research Approach

The study took a social constructivist approach which regards knowledge as socially and culturally contextual (McMahon, 1997; Kim, 2001). The study used the photovoice method (Appendix 1b) which enabled participants to share their socially and culturally contextual knowledge about food choice sourcing, and consumption (FCSC) unveiled through focus group discussions.

The study leveraged on existing research relationships with community leadership structures to access participants. Participants (Table 1) were identified through snowball sampling starting with people involved in previous research projects, who referred residents willing to participate in the study. Participants recruited were low-income earners dependent on casual jobs or Social Grants and had access to a mobile phone with a camera.

Table 1. Participant Recruitment

Settlement Name	Participants	
	Recruited	Participated
Rural M	9	11*
Peri-urban N	10	10
Peri-urban M	10	6
Informal settlement QRW	16	15
Informal settlement T	10	6
RD HF	10	6
RDP C	6	6
Total	71	60

*Appendix 1c

2.2. Data Collection

Two participant workshops were held. The first workshop was held to obtain informed consent, explain the photovoice method, and start the first phase of data collection. Three questions were presented to guide participants in taking pictures over a period of one week:

- What is healthy food?
- What are your meals composed of?
- Where do you access food?

During the second workshop, participants submitted photographs which were labelled and saved on a storage disc. Semi-structured focus group discussions were held to understand participants' photographs and to discuss additional questions. Participants wrote photograph descriptions on sticky notes and stuck them on flip charts. All the responses and discussions were recorded on a voice recorder and major points during the discussions were captured on a flip chart. Both workshops were held in isiZulu.

2.3. Data Analysis

Each set of pictures was organised into collages for each site while narratives from focus group discussions were analysed using the inductive thematic approach. Audio recorded narratives from focus group discussions were transcribed verbatim into Microsoft Word document and translated from isiZulu to English. The researchers familiarised themselves with the data and created a coding sheet using the research questions. Using the codes, themes emerging from the data were generated and defined (Appendix 1d: Table 1). Researchers reviewed emerging themes to ensure that they represented the ideas in the data and were not overlapping. Resultant themes were used in the presentation and discussion of results.

3. Results and Discussion

During focus group discussions, participants used significant political phases in South Africa's political history as timeframe reference points (Appendix 2a). As such, wherever timeframes were necessary, results were presented and analysed according to the three categories: after 1990; 1980-1990; and before 1980 (Table 2).

Table 2. Demographic Characteristics

Demographics		Rural	Peri-Urban		Informal Settlement		RDP Housing		Total
		M	N	M	QRW	T	HF	C	
Participants	Participated	11	10	6	15	6	6	6	60
Gender	Male	4	4	1	5	3	0	1	17
	Female	7	6	5	10	3	6	5	37
Age Groups*	Range	50	49	33	32	43	15	47	-
	Mean	40	48	56	36	49	52	31	-
	After 1990**	3	0	0	4	1	0	1	8
	1980 - 1990	4	4	1	6	0	0	4	15
	Before 1980	4	6	5	5	5	6	1	31
Education Level	No education	0	0	0	0	1	1	0	2
	Primary	0	0	2	3	2	2	1	10
	Grades 8 - 12/Matric	0	0	4	7	3	3	4	21
	Tertiary	0	0	0	5	0	0	1	6
Income (R)	<1000	5	2	0	2	1	1	1	5
	1001 - 2000	4	5	1	8	4	1	1	15
	2001 - 3000	2	3	1	3	1	1	2	8
	3001 - 4000	0	0	4	2	0	3	2	10

*Appendix 2a; **All participants in this category were above 18 years old.

3.1. Results

3.1.1. Food Diaries

Participants food diaries (Figure 1; Appendix 2e: Table 5) consisted of local foods such as *phuthu,* steamed bread; and global foods such as bread, rice, and stews. In both study contexts (Informal settlements and RDP housing (urban); rural and peri-urban), at least one participant indicated that they consumed home-grown fresh produce such as pumpkins, taro, and fresh maize. They also consumed indigenous food such as green leafy vegetables (GLV), *isigwaqana*, *isigwamba,* and *isijingi* (see Appendix 2d(ii) for description of indigenous foods):

> 'I enjoy biryani because I do not eat curry and rice as I come from a township.' (Participant 1, Informal settlement QRW).
>
> 'We ate indigenous food while growing up, that is why we love to eat it. I feel strong when I eat indigenous food.' (Participant 4, Rural area M).

Peri-urban M

Peri-urban N

Rural area M

Informal settlement QRW

Informal settlement T

RDP HF

RDP C

Figure 1. Food Diaries of a Day's Meals

Participants born before 1990 consumed indigenous food as a staple before 1990. In both study contexts, participants recollected memories of home-grown fresh produce and indigenous food production, processing, and consumption which they seldom practice post-1990. However, participants born after 1990 depicted fewer or no similar memories, especially in informal and RDP housing where they identified older community members who consumed indigenous food daily. Overall, participants from rural and peri-urban settlements had more memories compared to the informal and RDP settlement participants born after 1990. The Peri-urban N and Rural area M participants consumed indigenous food though they preferred global foods.

3.1.2. Healthy Food

Home-grown fresh produce, GLV, and indigenous food were considered healthy in both study contexts and across all age groups. Home-grown fresh produce was considered healthier than storebought fresh produce because of freshness and knowledge of inputs used in food production. Some foods were considered healthy because of perceived medicinal value [Table 4; Figure 2; Appendix 2b(i)].

Table 4. Foods with Medicinal Properties

Study Site	Foods & Nutrients	Value
Rural M Informal settlement QRW	Indigenous foods - vitamins, minerals, carbohydrates, protein, fat, and oil.	Decrease body fat
Peri-urban M	Pork fat	Blood Purification
Peri-urban N	Boiled foods	Well-being
Informal settlement QRW	Beetroot Carrots – vitamins Vegetables – vitamins Beef liver Cabbage – vitamins Beef – protein Rice – Carbohydrates Oranges - vitamin C Apples – vitamins Milk – calcium Cucumber – vitamins	Blood production Eyesight Health Blood production Has vitamins Well-being Body function Well-being Cleans teeth Makes you strong Cleanses the eyes
Informal settlement T	Beans	Filling and gives energy
RDP HF	Balsam pear leaves	Blood pressure regulation

Figure 2. Healthy food - homegrown fresh produce, GLV & indigenous foods

Further, food was considered healthy depending on preparation method. Boiling, and steaming foods; and cooking with little use of additives or condiments made food healthy. Participants appreciated indigenous and home food production, processing, and preparation methods because home processing does not eliminate 'the healthy stuff' from food (Appendix 2c: 1c).

> '…the food we eat is not healthy compared to what we ate when we were young; food was healthy, and we did not get sick. Technology makes the situation worse because they use chemicals to produce food.' (Participant 6, Rural area M).

> 'I prefer village chicken because it feeds on sand to gain minerals, which are good for our bodies. Store-bought chickens are fed chemicals. We don't know where they're grown and how long they're kept in the fridge. The store-bought chicken is not healthy compared to the village chicken. Village chicken is nice and strong;

> If you want to slaughter it, you must run fast to catch it.' (Participant 1, Rural area M).
>
> 'All the food we buy is unhealthy: food like cooking oil, packet soups, stock cubes, and spices. There's also too much salt in the food. All these fake foods are very nice. Then there's chicken that grows from a chick into chicken within three weeks, and it is huge like a pig…that is why we have Corona Virus today.' (Participant 3, Peri-urban area N).

In both study contexts, participants born after 1990, appreciated good health outcomes of older family and community members, which they associated with consumption of home-grown fresh produce and indigenous food. Participants' perceptions of healthy food were influenced by memories of past food consumption behaviour and health outcomes. However, participants preferred to consume processed store-bought and convenience foods. Informal settlements and RDP housing pictures depicted fast-food, and focus group discussions revealed street-fast-food as everyday foods. Nevertheless, participants from all contexts were concerned about unhealthy food choices and about commercial food production, processing, and preparation habits.

3.1.3. Food Choice, Sourcing and Consumption

Before 1990, participants born before 1990 consumed mostly home-grown foods such as pumpkins, sweet potatoes, maize, beans, taro, GLV, wild fruits, fish, and meat. They consumed home-processed foods daily, while commercially processed foods were consumed occasionally (Appendix 2c). Commercially processed foods were not available then, in contrast to post-1990 (Figure 3). After 1990, participants from all study sites bought most of their food from supermarkets, spaza shops, and other sources identified [Appendix 2b(ii): Table 3a, b, c & 2c]. Particularly, participants from informal settlement and RDP housing relied on store-buying as they had little or no space for food production. Some RDP C participants occasionally bought fresh produce from individual or communal gardens.

> 'It is difficult to get fresh produce, we rely on shops in Emtshebheni, Bridge City, or Durban. We get small items from foreigners' shops around here. We got food parcels during lockdown; we still get cooked food every Wednesday.' (Participant 2, RDP C).
>
> '…we get some food from the gardens and most of it from the shops' (Participant 2, Peri-Urban N).

Figure 3. Store-bought foods

In both study contexts, participants correlated changes in food sourcing to major political changes in South Africa. Before 1990, household food production, food exchange, foraging, fishing, and hunting were the main means of accessing food, with occasional store-buying of processed foods. After 1990, food sources changed to mainly store-buying, food donations through feeding schemes and government assistance, minimal food production, foraging, and fishing. In both study contexts, participants depended on store-bought food which some households supplemented with home-grown or foraged food. Household food production, foraging, and fishing are still seen as the best ways to source healthy food as the consumer is aware or in control of the inputs into food production processes. In the rural and peri-urban context, food production is done on a smaller scale post-1990. However, most of the informal settlements and RDP participants do not practice food production, and participants born after 1990 see food production as a bygone food source.

Healthy FCSC and acceptability varied across age-groups. Participants born before 1990 consumed healthy food more than participants born after 1990, though they did not consume healthy food as often due to various reasons (Table 6; Appendix 2f).

Table 6. Factors influencing FCSC.

Factors influencing FCSC	Study Site	Profile of participants	Reasons for not consuming healthy food
Aspirations & Social Status	All	All	Inferior food sources & healthy food.
	Peri-urban area N Rural area M	1980 - 1990 Before 1980	Post-apartheid vs. food production.
	Rural area M Peri-urban area N	After 1990	Technology use vs. food production, processing, and consumption.
Cost of food	All	After 1990	Cost of Healthy food: Shrinkflation vs. growing families.
Education & employment	Rural area M Peri-urban area M & N	Before 1980	Inadequate labour for food production and processing.
Climate change	Rural area M Peri-urban area M & N	1980 - 1990 Before 1980	Changing weather patterns affect food harvests.
Land-use change	Peri-urban M	1980 - 1990 Before 1980	Conversion of agriculture land to housing.
Urbanisation	Informal settlements QRW & T RDP HF	1980 - 1990 Before 1980	Limited space for food production

Participants born after 1990 preferred: store-bought and convenience food to home-grown fresh produce; to spend their time using technology and media over food production, processing, and preparation. Overall, store buying was perceived as depicting a higher social status than food production or foraging which are linked to the poverty of the past. Participants aspired for a life depicted on media as a life lived by '*abelungu* - the white people'; a life that does not include household food production, fishing, foraging, and consumption of GLV or indigenous food. These aspirations define an ideal diet for a financially stable household. In this study, foods defined as 'healthy' fall outside of socially acceptable foods because they signify poverty or hardships of the apartheid era. The post-apartheid era is regarded as a period of freedom from the food poverty of the past. Thus, participants sought freedom from their rural lifestyle of food sourcing, processing, preparation, and communal sharing of food.

Food sourcing through household food production, foraging, fishing, and hunting on a scale large enough to sustain household food needs is not possible in both contexts for several reasons. Firstly, recurring droughts and floods have impeded household food production over the years. Though some households still produce food, the harvests cannot sustain household food needs. Secondly, rural-urban migration, politics, employment, and education changed the family structure and functioning during the period 1980-1990 and post-1990. Households lacked labour to support food production because family members took up jobs or went to school. This is evident by the high number of participants born before 1980 that participated in this study most of whom were female. Working women perceived food production and processing as labour intensive and time consuming, hence their preference for convenience foods. Thirdly, the size of agricultural land in peri-urban settlements has been shrinking due to urban sprawl.

In the urban context, there is no land allocated for food production. Lastly, rising food prices since the 2008/9 global recession made it difficult to make healthy food choices.

4. Discussion

GLV, indigenous food and home-grown fresh produce are healthy foods. Boiling food is the best way to prepare healthy food. WHO and FAO recommend eating locally sourced fruit, nuts, pulses, and vegetables; boiling foods; and, eating less processed foods as part of a healthy diet (see Fischer & Garnett, 2016; WHO, 2020). Nevertheless, nuts were absent from the meals while diversity was beyond the scope of this study.

South African consumers consider GLV and indigenous food healthy (Makweya & Oluwatayo, 2019; Sedibe et al., 2014; Molebatsi et al., 2010). Nevertheless, the length of time between harvesting and food preparation, food preparation methods, and additives used in food determine whether food is considered healthy. Despite a wealth of knowledge displayed about healthy food consumption and consequences of unhealthy food consumption, consumption was undesirable, especially amongst the younger generations in both study contexts. Unhealthy food choice, production, processing, and preparation methods remain a concern, given the high incidence of NCDs. Government has responded through regulations such as a zero-rating value added tax on healthy food, salt reduction, nutrient fortification, responsible advertising, and a sugar tax (Boatemaa et al., 2018, p. 273; Republic of South Africa, 2016; Haggblade et al., 2016, p. 227; South African Department of Health and UNICEF, 2008).

Food sourcing changed from predominantly home-growing to store buying. Home-grown fresh produce from fields, individual or community gardens supplemented storebought food. More rural and peri-urban meals were composed of home-grown fresh produce compared to the informal settlement and RDP housing meals; this corresponded to the accessibility of healthy food and intensity of food production (Ramkisoon, 2018). Household food production in peri-urban areas has been decreasing due to reduction in agriculture land (Roberts & Shackleton, 2018), which is converted to housing developments (Dlamini, 2015). However, in informal settlements and RDP housing, lack of agriculture land is attributed to population density (Ramkisoon, 2018; McConnachie & Shackleton, 2010).

The underlying factor affecting healthy FCSC is consumer aspirations for a better life. Stereotypes influenced perceptions of socially acceptable foods and food sourcing especially amongst the younger generation. Research shows that youths look down on indigenous food and food production because it is associated with poverty (Nepfumbada et al., 2021; Akinola et al., 2020; Trefry et al., 2014). By contrast, consumption of processed store-bought and convenience foods is seen as a sign of economic prosperity (Akinola et al., 2020; Sedibe et al., 2014).

This study reveals an evolution in food consumption habits. Older generations appreciated healthy FCSC because of previous experiences of food which younger generations did not have. Studies show that decision-making is biased towards present options in memory and therefore, remembered feelings associated with food drive food choice and consumption (Gluth et al., 2015; University of Basel, 2015; Higgs, 2011). Nevertheless, older generations perpetuate stereotypes that discourage healthy FCSC by relating current food choices to past lived experiences of food. In turn, the younger household members learn and perpetuate unhealthy food consumption behaviour by pressuring their guardians to provide unhealthy food.

The cost of healthy food was perceived to affect FCSC. Food prices are too high for the majority of South Africans (Statistics South Africa, 2018) which can be attributed to rising food prices since the 2008/9 global recession (Temple & Steyn, 2009) and more recently the COVID-

19 pandemic and looting (Jafri et al., 2021). Consequently, consumers prioritise quantity over quality, safety, or food production processes (Koen et al., 2018; Vermeulen et al., 2015).

Lastly, climate change, rural-urban migration, urbanisation, and modernisation affect FCSC. Further, socio-economic, and technological advancement have made food preparation easier due to availability of convenience foods. However, more time spent using technology and everyday socio-economic activities leaves little time for food preparation and hence intensify the need for convenience food.

FCSC is deeply rooted in the past. Current FCSC behaviours were perceived to have evolved because of the past, that is, firstly, food consumption behaviour developed during the struggle for independence from the apartheid era. Secondly, consumption behaviour developed post-apartheid which is largely an interpretation of what freedom means in relation to FCSC. Though transformation in FCSC is a global phenomenon, the characteristics are unique to local contexts (Herrero et al., 2021) as demonstrated in this study. Interventions aimed at changing the *status quo* for sustainability need to understand the culture and values within the relevant area (Herrero et al., 2021; Von Braun et al., 2021).

5. Recommendations and Implications for Policy

We would like to highlight the following issues, which have implications for policy advancement:

- Healthy food is associated with poverty and therefore is not aligned with consumer aspirations, especially the younger generations. Advancing healthy FCSC requires redefining healthy FCSC narratives using popular approaches that appeal to the younger generations. Behaviour change campaigns and awareness should consider consumers' construction of acceptable food within the context of South Africa. Such campaigns can highlight new trends in the Western countries where consumers are willing to pay more for healthy food.
- The study depicts a dependency on storebought foods and the high cost of fresh produce. This presents an opportunity for producing and supplying fresh produce for low-income earners by low-income earners. It also has the potential for co-benefits in meeting various mandates and government priorities such as job creation in the agriculture and food retail sectors. However, since food production is undesirable by younger generations, behaviour change campaigns should deconstruct negative perceptions and narratives surrounding food production.
- A lack of food production space within urban low-income settlements hinders food production. Planning, designing, and construction of low-income housing should make provision for green spaces for food production, among other uses.

6. Conclusion

Daily food choices are deeply rooted in consumer aspirations for a superior lifestyle evident in the food consumed. These aspirations define and perpetuate unhealthy FCSC behaviour and can have negative ramifications on efforts towards development of sustainable healthy food systems. Nonetheless, this study shows that consumers possess a wealth of knowledge about healthy FCSC based on positive first-hand lived experiences and outcomes of consuming healthy foods. The knowledge and attitude towards healthy FCSC can provide leverage for development of sustainable healthy food systems. Since knowledge and experience are intergenerational, and in the case of this study, the knowledge is not transmitted to the next generation, it brings urgency to efforts that would leverage on the identified knowledge and attitudes whilst they last.

This study opens discourses on consumer aspirations and impact on FCSC behaviour in South Africa. Understanding aspirations in relation to food consumption behaviour is important in deliberations about developing sustainable healthy food systems' policy in South Africa and elsewhere.

7. Limitations of the Study

This study took a qualitative approach, which limits opportunities for replication. Though the researchers planned to replicate each study site, the last stage of data collection was impeded by the COVID-19 lockdowns in 2020. Consequently, the rural settlement site was not replicated. Further studies in large and small cities in KwaZulu-Natal and other provinces can provide more insights into consumer aspirations in relation to FCSC behaviour in South Africa.

Disclaimer

The views expressed in this paper do not necessarily reflect those of the University of KwaZulu-Natal.

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Conflict of Interest

The authors (Chinzila CB, Buthelezi S, Khumalo D and Sutherland C) declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Research Note

Food or Fuel?
The Case for a US Strategic Corn Reserve and Food-Fuel Throttle to Reduce Global Hunger During Food Price Spikes

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Abstract: Corn, at 47 billion bushels annually, is the second most produced crop globally, serving as a key staple food for billions. The U.S. is the world's largest producer and consumer, producing 13.7 billion bushels in 2023. Out of this, the US uses roughly 40% to produce fuel for cars and trucks, because of the Renewable Fuel Standard (RFS), with 40% used for animal feed and the remaining 20% going to food and other uses. In recent years, world events such as Covid and the Ukraine war have caused food price spikes, resulting in severe hunger for the global poor, especially the millions at the margins of food affordability in Sub-Saharan Africa. It could be strategically beneficial for the US to adjust its corn storage and allocation policy. This paper sets forth two policy proposals: (1) Strategic Corn Reserve (SCR) to store corn for periods of soaring prices modeled on the Strategic Petroleum Reserve (SPR); (2) Fuel-Food Throttle (FFT) for flexible usage of corn as fuel or food depending on the situation. The benefits of these policies would significantly outweigh the costs, by reducing hunger in critical moments and countering foreign influence in poverty-stricken regions such as Sub-Saharan Africa. To execute these bold policies will require either an executive order and/or congressional legislation, as well as developing pathways for storage and flexible use, which are outlined within.

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1. Agriculture
2. Energy Production
3. Food Security
4. Policy Reform
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1. The Problem – Food Price Volatility and Severe Hunger

Motivating this paper is a report by the FAO and other global agencies (2023) stating that severe food insecurity has been steadily rising since 2014, and since 2010 in Africa. In 2022, 30% of humanity, 2.4 billion people, could not afford a healthy diet costing the equivalent of $4 per day. And as we have seen in recent years, food prices can spike suddenly, like in early 2022 when wheat prices spiked by 50%. Events such as this cause much more hunger for individuals and families at the global margin of food affordability, many of whom are in lower-income countries. While food prices have come down since then, long term volatility factors like increased extreme weather, crop yields, and political tensions could very well cause future spikes.

Food price spikes are a problem for US consumers also – food inflation causes stress, and forces hard sacrifices for everyday Americans. 2022's inflation rightfully gained substantial media coverage. The volatility of food prices puts the health and survival of the world's poor and US national security at stake.

Grains are the world's staple food – rice, wheat, and corn provide over half of the world's food energy. Of the grains, corn is the most produced, at 47 billion bushels annually, 50% more than wheat. The US is the world's leading producer of corn at 13.7 billion bushels in 2023. Of this 13.7 billion, a staggering 38% or 5.2 billion bushels, was processed into 15 billion gallons of ethanol for fuel in motor vehicles (US Department of Energy, 2024). This is because the law requires every American to use E10 gasoline, a fuel that is made of 10% ethanol from corn, in their car. The high usage of corn for ethanol raises some serious questions.

From the food perspective, it seems to be highly inefficient when millions around the world are going hungry. Based on typical calorie needs and the corn required for ethanol, the amount of corn required to fill up a large SUV once if using 100% corn ethanol would be enough to feed a human being for an entire year.[1]

From the energy perspective, corn ethanol doesn't make much sense either since it's less efficient than gasoline. A recent study funded by the US Department of Energy (DOE) found that ethanol is likely at least 24% more carbon-intensive than conventional gasoline, largely due to energy needs to grow and process the corn (Lark et al., 2022).

2. Historical Context and US Policy on Grain Reserves

Over the years, the United States has implemented and rolled back or otherwise adjusted several strategic grain subsidies and reserves to boost grain production, stabilize grain prices, and ensure food security. Since 2008, the US has not held a nationwide grain reserve.

One of the earliest reserves was the Farmer-Owned Grain Reserve (1977-1996), which allowed farmers to store grain with the aid of government loans, helping to stabilize prices and maintain a steady food supply. This was followed by the Food Security Wheat Reserve (1980-1996), which specifically focused on wheat and aimed to meet international food aid commitments while also addressing domestic emergencies. In 1996, this reserve was expanded into the Food Security Commodity Reserve (1996-1998), which included other grains to support more comprehensive food security goals.

In 1998, the focus shifted with the establishment of the Bill Emerson Humanitarian Trust. Named after Congressman Bill Emerson, this trust initially held both grain and cash, but since 2008, it has maintained only a cash reserve. This cash is used to purchase food during unexpected food crises, allowing the U.S. to respond quickly to international food aid needs

[1] From Cornell University, an acre of U.S. corn yields about 7,110 pounds of corn for processing into 328 gallons of ethanol, which for a typical SUV twenty-gallon tank comes out to 433 pounds of corn (Pimental, 2001). Given a pound of corn yields about 1,566 calories according to an article by the Washington Post's Tamar Haspel (2015), multiplying 433 by 1,566 and dividing by 365 days in a year gives us 1,860 calories, or enough to feed a sedentary forty-year-old woman (WebMD).

without the logistical challenges of storing physical commodities. This evolution reflects a broader shift from market stabilization to more flexible, direct humanitarian assistance.

But being a cash reserve, the Bill Emerson Humanitarian Trust comes with drawbacks like being subject to higher food prices when it needs to purchase food for aid. It is also only for foreign aid and cannot support the US in the case of a global food crisis. As of 2024 the trust only has $280 million in funds remaining, with its most recent disbursement ($200 million) happening in 2022 to support Sub-Saharan Africa, leaving the future of the fund an open question (US Agency for International Development, 2024).

Meanwhile in recent years China, the US's largest strategic rival, has been building its grain production capacity and reserves to ensure national food security amid growing global uncertainties. The Chinese government has taken the lead on this initiative, and it seems to be working. According to a recent article in the *Global Times*, these programs have resulted in record grain harvests, with 2023 seeing a total output of 695 million tons (Lin, 2024). These efforts include expanding cultivation areas, particularly in regions like Xinjiang, which saw a 16% increase in planting area and output (Zuo, 2023). Strategic reserves have been bolstered to maintain a grain reserve-to-consumption ratio well above the safety threshold recommended by the UN Food and Agriculture Organization.

To improve the efficiency and management of its vast grain reserves, China established the China Enterprise United Grain Reserve Company Ltd. in 2022, a joint venture between major state-owned enterprises Sinograin and COFCO. This move, according to an article in *The Diplomat*, aims to streamline reserve management and address issues of corruption and mismanagement that have previously plagued the system (Donnellon-May, 2024). Additionally, China continues to diversify its agricultural imports and strengthen international cooperation, particularly with countries involved in the Belt and Road Initiative, to mitigate the risks posed by geopolitical tensions and climate change. As stated by the Sino-German Agricultural Centre (DCZ), these comprehensive strategies highlight China's commitment to securing its food supply and stabilizing domestic grain markets (Behme, 2022).

Considering the US history, current policy, and what players like China are already doing, we should strongly consider reviving a US corn stockpiling policy.

3. Historical Context and US Policy on Corn Ethanol Fuel

The US is the world's leading producer of corn ethanol, a type of biofuel, or fuel made from direct biomass rather than fuel like oil. Countries like Brazil, Indonesia and some European nations round out the other top producers of biofuels. This production capacity was spurred in the US by the Renewable Fuel Standard (RFS), administered by the Environmental Protection Agency (EPA).

Almost all gasoline in the US today is "E10", or a blend of 10% corn ethanol/90% gasoline. The main policy that drives corn ethanol production is called the RFS, which mandates that refiners produce certain amounts of biofuels and provides credits for overproducers.

The Clean Air Act established the RFS in 2005, and the Energy Independence and Security Act in 2007 further expanded it. The RFS's goal is to promote alternative domestic energy production via biofuels, and the EPA has jurisdiction over the program in consultation with U.S. Department of Agriculture (USDA) and the DOE.

The original law set continually increasing volume targets through 2022, starting with 4 billion gallons in 2006 solely from corn ethanol and planning for 32 billion in 2024, with the contribution of other, so-called "advanced" biofuels. The law capped corn ethanol at 15 billion gallons, to avoid diverting too much corn from food and feed uses, which took effect in 2017.

The EPA has consistently reduced advanced biofuels requirements due to lack of available supply, meaning corn ethanol makes up almost all the US biofuel production.

4. Mechanics of the Renewable Fuel Standard (RFS)

To meet the RFS, refiners usually blend corn ethanol and other biofuels into gasoline. The EPA has the authority to set the RFS requirement each year. It can then use targets based on refiners' fuel sales to calculate their Renewable Volume Obligation (RVO). To comply with the program, refiners need to show a certain number of Renewable Identification Numbers (RINs), or tradable credits, which are generated when producing the fuel and can be bought and sold. RINs are created when making a specific kind of biofuel, and RIN prices reflect the marginal cost of producing and consuming renewable fuel.

Low RIN prices mean that the market thinks that the RVO will be easy to achieve, while high prices mean the opposite. If a refiner makes a gallon of ethanol, they get one D6-level RIN – as of April 22, 2024, a D6 RIN costs $0.66 (US Environmental Protection Agency, 2024). Refiners who don't make enough ethanol have to buy more RINs to reach the target percentage. The RIN prices act as an effective tax on gasoline and an effective subsidy on renewable fuels, and the ethanol fuel target (currently 10% of total US gasoline) becomes the "breakeven" blend showing how the RIN has its impact.

The EPA can annually set biofuel targets, and in recent years it has fallen below the original goal of 36 billion gallons set by the EISA in 2007. The total amount of biofuels has consistently risen in the past 3 years, reaching 20.8 billion gallons in 2023, mainly driven by ethanol increases (United States Environmental Protection Agency, 2023). The EPA can set new requirements in 2024 and 2025 based on factors such as future production expectations, environmental impact, and others – food prices among them.

5. Price Impacts of the RFS and Corn Supply-Demand Dynamics

According to most economic research, biofuel production affects crop prices. The EPA cites research that shows that the RFS program raised corn prices by 20-40% globally depending on how impacts are measured (Condon et al., 2015). Also, a comprehensive review of 157 studies on the effect of corn ethanol on prices found that corn prices increase proportionally with ethanol production (Timmer, 2008). And a summary of studies on the impacts of biofuels finds a price impact of between 3-5% per billion-gallon increase in corn ethanol, with decreases similar in proportional scale (International Council on Clean Transportation, 2021).

There is sparse data about the elasticities of crop supply and demand. But in the short run, an increase in ethanol usage of corn and RFS requirements elevates the global price of corn, which according to Rosegrant et al. (2008) may lead to higher rates of malnutrition in the developing world. Another study found an extremely strong relationship between the FAO Food Price Index and corn ethanol production, with the latter being the only factor found to support the former's upward trend from the early 2000s to today.

On the other hand, government subsidies and support for corn ethanol like RFS can stimulate increased corn production over several years which leads to increased supply over time. So increased RFS ethanol standards may reduce corn prices over the longer term.

But in the short-term (<1 year), demand is variable, and supply is fixed for corn, meaning that increases in ethanol use directly take away from corn that could be used for food purposes. A Congressional Budget Office study (2014) found that increased corn demand for ethanol contributed to 20-40% of the corn price increase seen from 2008-2009, since supply did not increase sufficiently to compensate.

Additionally, corn's prices affect the prices of other key, staple crops due to substitutability for consumption and land use competition for production. A recent analysis using econometric models as well as land use techniques found that the RFS increased corn prices by 30% as well as soybean and wheat prices by 20% (Stein et al., 1977).

Biofuels also increase the price of meat by increasing animal feed prices – one study found that biofuel production increased the retail price of broiler meat in 2007-2009 by 6-12% percent (Pollen, 2006). All this is to say that there may be a short-term opportunity to reduce those prices by bringing on extra food supply in times of dire global hunger.

6. Proposed Two-Part Solution

There is a way to better leverage the US corn supply to meet the needs of the global poor and to protect domestic consumers in times of food price spikes. This paper proposes a two-prong solution:

- Create a "Strategic Corn Reserve" (SCR) modeled off the Strategic Petroleum Reserve (SPR) to store this important grain for times of dire need, foreign and domestic.
- Introduce a corn "Fuel-Food Throttle" (FFT) to function as a release valve during food price spikes.

6.1. A "Strategic Corn Reserve" Provides Important Benefits

An SCR in the U.S. would provide multiple benefits, including market stabilization, food security, and emergency preparedness. By holding a reserve of an essential grain such as corn, the government can mitigate the effects of supply disruptions caused by natural disasters, geopolitical events, or market volatility. This reserve would help stabilize prices, ensuring that sudden shortages do not lead to spikes that could harm consumers and the agricultural economy.

Implementation of a strategic grain reserve would involve creating infrastructure for storage, like the existing SPR for oil. The SPR is an emergency stockpile of oil held underground in Texas and Louisiana and managed by the DOE. It is the largest known supply in the world with a capacity of 714 million barrels, developed to address the 1973 energy crisis. The U.S. Strategic Petroleum Reserve (SPR) is the world's largest emergency crude oil stockpile, established in 1975 to mitigate supply disruptions and stabilize oil markets. It consists of underground storage caverns located in Texas and Louisiana, capable of holding up to 727 million barrels of oil. According to the DOE, Section 161 of the Energy Policy and Conservation Act (EPCA) gives authority to the President to tell the Secretary of Energy to conduct sales and purchases from the SPR. In situations of severe and even some lesser energy supply disruptions, the DOE can sell SPR oil in a competitive auction to the highest bidder (U.S. Department of Energy, 2015).

Like the SPR, a possible U.S. corn reserve would work by keeping extra corn that could be used during times of low supply or high prices. This would help balance the U.S. corn markets and guarantee food security. Like the SPR, a corn reserve would involve presidential oversight to manage stockpile levels and release schedules, selling the corn in the open market to cushion against price shocks. Managed by the USDA with facilities located in key agricultural regions across the US, these facilities would need to be equipped with modern technology to manage and preserve copious quantities of grain efficiently. The government would oversee the acquisition of surplus grains during periods of high production, ensuring that farmers receive a fair price for their produce. This would also provide a safety net for farmers, helping to buffer against market fluctuations.

Management of the SCR would include regular monitoring and quality control to prevent spoilage and ensure the grains remain viable for use during emergencies. The reserve could be rotated periodically to keep the stock fresh, with older stock released to the market in a controlled manner to avoid disrupting current production and pricing. Coordination with private sector storage and distribution networks would be crucial to ensure seamless integration and efficient handling of the reserves.

There should be an established pathway for delivery of corn to poor countries in times of specific need. This could entail special Navy or shipping routes coordinated by USAID from New York or Baltimore to provide aid to key African ports like Lagos, Nigeria during food price spikes.

In addition to market and emergency stabilization, the SCR would support national security by reducing dependence on international grain supplies. This is particularly important in the context of global supply chain vulnerabilities highlighted by recent geopolitical events. By creating an SCR, the U.S. would be better positioned to respond to international crises that affect food supply chains, ensuring that the nation remains resilient and self-sufficient in critical food commodities.

6.2. A Corn "Fuel-Food Throttle" Would Establish Flexibility in US Corn Usage as Food or Fuel in Times of Crisis

The corn "Fuel-Food Throttle" (FFT) is a proposal – complementary to the SCR – that will enable the flexible usage of corn as food or ethanol fuel based on the global food price situation. The policy would be an overlay to the RFS and be triggered by food price increases according to presidential discretion. It would establish a pathway for the diversion of ethanol corn to food purposes, which would require coordination between government departments and with the private sector. This policy would need to balance food and fuel production, consider environmental and economic sustainability, and ensure trade and market stability.

As explained before, in the immediate term, when corn becomes fuel, there is less food for people. And in the short-term, food corn costs more because of ethanol mandates. The FFT will make more food available in the short term by moving corn from ethanol to food uses like cornmeal and polenta, which would help with domestic stability and foreign aid when food prices are high.

The US can decide whether to use corn for food vs fuel, and how much would be used a given year, using the adjustable RFS and special Presidential-led measures to intervene. The FFT would be overseen by the USDA with additional presidential involvement and discretion, allowing for additional flexibility in times of crisis. An example of a trigger for the throttle could be a certain grain price increase over the previous 2-year average, e.g. >40%, at which point the FFT would activate, and farmers would be given a special incentive along with a temporary RFS reduction to immediately divert corn from fuel to food. The exact mechanism would need to be determined via a thorough engagement of all relevant stakeholders. And the diversion could either be a direct diversion of corn as food to those in need, or the price effects of increased corn supply would indirectly help reduce global hunger through lower prices.

For a rough price impact estimation, if the US reduced biofuels usage by 27% from 15 billion gallons to 11 billion gallons, best estimates suggest that corn prices would likely drop by at least 10% (2.5% * 4 billion), and other prices of competing grains such as wheat and soybeans may also drop by around 7%. These lower global grain prices would directly help feed the world's poorest, who are often starving in periods of food price spikes. The impacts of more affordable corn will also benefit Americans who eat meat, through an increase in the supply of animal feed which will reduce meat prices.

This policy will need leadership from the executive branch of government and the President, as well as coordination between public and private sectors and across government agencies. The government and farm industry groups and trade unions should work together to make sure that the policy changes are fair and compensated. The EPA, the USDA, and the DOE will also be involved in these initiatives, with the president's input if needed.

A comprehensive U.S. corn fuel-food policy like the FFT must address the delicate balance between allocating corn for food production and biofuel production. Corn is a staple in the American diet and a crucial feedstock for livestock, but it is also a primary source for ethanol production. The policy should ensure that food security is not compromised by the diversion of excessive corn to biofuels. One way to do this is to limit the quantity of corn that can be used for ethanol through the RFS guidance and encourage the use of other sources of biofuel, such as switchgrass or crop residues.

Environmental sustainability is another critical component of the policy. Corn cultivation is resource-intensive, requiring significant amounts of water, fertilizers, and pesticides, which can lead to environmental degradation. The FFT should incentivize sustainable farming practices, such as crop rotation, conservation tillage, and precision agriculture, to minimize the environmental footprint of corn production. Economically, the policy should support farmers through subsidies or incentives that promote the adoption of sustainable practices and ensure that they are not financially disadvantaged by shifts in policy priorities.

Lastly the FFT must consider the implications of corn production on trade and market stability. The U.S. is a major exporter of corn, and changes in domestic policy can have significant global repercussions. The policy should maintain stable corn prices and ensure reliable supply chains. This requires working together with other countries to avoid trade conflicts and reduce the effects of global market changes. Also, helping research and development in corn production technologies can improve efficiency and adaptability against market and environmental difficulties.

7. Conclusion and Next Steps

In view of the highly volatile global food situation of the past couple of years, with Africa gravely affected, US ethanol production should be flexible. The “field corn” used to make ethanol can be milled and prepared – e.g. as polenta – for human consumption. In this paper, I advocate two specific policies: 1) a Strategic Corn Reserve (SCR), modeled off the SPR for oil, and 2) a corn Fuel-Food Throttle (FFT).

Research outlined above indicates that these policies could, in conjunction, reduce short-term global corn prices by ten percent and prices of other staples by about seven percent. In the case of a food price spike, a hypothetical re-allocation of one-third of U.S. ethanol production from fuel to food would free up 1.9 billion bushels of corn per year, enough to add five hundred kcal/day to the diets of nine hundred million people.

Clearly, the policy would be a lifesaver for the vast majority of the world’s poor, especially those in African countries who often import maize from the open market, and even those in America who cannot afford healthy foods when prices rise sharply.

Presidential support would be necessary to push this policy forward. Acts of Congress could facilitate, and bipartisan support should be possible given the importance of such an initiative to national security and global diplomacy, not to mention the genuine benefits of feeding the world’s poor. This is an opportunity for the US to take ambitious action – reducing hunger with these policies is an opportunity for the US to lead the world in policy innovation and global altruism.

I encourage the USDA Economic Research Service and other research groups to further investigate these topics. I urge the EPA, Department of Energy, and USDA to conduct diligence on the SCR and corn ethanol food throttle with an eye to fast-tracked implementation.

Disclaimer

The views expressed by the author are his own, and not associated with his affiliations. The author declares no conflict of interest.

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