*sustainability*

MDPI

*Article*

# Building a Resilient and Sustainable Sorghum Value Chain in Tanzania's Lake Zone Region

**Assan Ng'ombe [1], Mupangi Sithole [2], Collins Muimi Musafiri [3], Milka Kiboi [4], Tomas Sales [2] and Felix Ngetich [3,5,*]**

[1] AGRA, West End Towers, 4th Floor, Muthangari Drive, Off Waiyaki Way, Nairobi P.O. Box 66773-00800, Kenya; angombe@agra.org
[2] United Nations Development Programme, UN House Level 08, Metropark Building, 351 Francis Baard Street, Pretoria 0001, South Africa; mupangi.sithole@undp.org (M.S.); tomas.sales@undp.org (T.S.)
[3] Cortile Scientific Limited, Nairobi P.O. Box 34991-00100, Kenya; collins.musafiri15@gmail.com
[4] Department of International Cooperation Ackerstrasse 113, Research Institute of Organic Agriculture (FiBL), 5070 Frick, Switzerland; milka.kiboi@fibl.org
[5] School of Agricultural and Food Sciences, Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Bondo P.O. Box 210-40601, Kenya
* Correspondence: felixngetich@gmail.com

**Abstract:** Climate change and low agricultural productivity are the major hurdles facing sorghum farming in the Lake Zone Region of Tanzania. However, there is limited information on the contribution of sustainable projects in greening the sorghum value chain in Tanzania. This study aims to analyze how to develop a resilient and sustainable sorghum value chain using a project approach. Primary and secondary data were collected and used. Primary data were collected using key informant interviews (KII) administered to the value chain actors using audio recordings and notes. Secondary data were obtained from project-related project documents, reports, publications, and conference proceedings. The audio recordings were transcribed into lengthy notes summarized for ease of interview theme identification. To enhance access to improved seeds and fertilizers and advisory services, a linkage between the agro-dealers (input suppliers), farmers, and extension personnel was established to improve farmers' yield potential. Good agricultural practices, e.g., planting methods and pest management and improved seed varieties that were drought tolerant, early maturing, and high yielding, such as Macia and Tegemeo, were readily available in shops and promoted through the establishment of demo plots. Local aggregation of sorghum grain helped to ease transport-to-market logistics for farmers and contributed to lower transport costs. Mechanized threshing was promoted to ensure the high-quality crop is sold to the off-taker for premium prices and meets the export market requirements. We highlight the Lake Zone project experiences and lessons learned to demonstrate the potential for building resilience and sustainability of the sorghum value chain.

**Keywords:** good agronomic practices; sorghum value chain; resilience; rural development; sustainabilitys



**Citation:** Ng'ombe, A.; Sithole, M.; Musafiri, C.M.; Kiboi, M.; Sales, T.; Ngetich, F. Building a Resilient and Sustainable Sorghum Value Chain in Tanzania's Lake Zone Region. *Sustainability* **2023**, *15*, 15107. https://doi.org/10.3390/su152015107

Academic Editors: Jose Navarro Pedreño and Manuel Miguel Jordan-Vidal

Received: 8 September 2023
Revised: 13 October 2023
Accepted: 13 October 2023
Published: 20 October 2023



## 1. Introduction

Sorghum (*Sorghum bicolor* L.) is among the major staple food crops in the world, and it is primarily grown in semi-arid regions [1]. The crop is used as human food, for alcoholic beverages, biofuel production, and animal feed for forage and fodder [2]. In Tanzania, sorghum is the third most widely grown cereal after maize and rice, with 834,284 hectares planted and yielding 500,000 tons [3]. It is a major food crop that determines food security in Tanzania [4]. The low productivity of sorghum is attributed to many constraints, including climate change-related variables such as highly irregular rainfall patterns, high incidences of drought, floods, pests, and diseases, poor soil fertility management, application of suboptimal agronomic practices, and use of inferior seeds [5–12]. Sorghum is relatively drought and heat-stress tolerant, making it a crop of choice in marginal agroecologies in sub-Saharan Africa (SSA) [13]. However, drought may limit the availability of soil nutrients for the plant, resulting in constraints such as poor seed germination and reduced crop flowering and embryo development after pollination. Nutrient management is a critical factor in rain-fed agriculture to improve food security in SSA to meet food demands [14]. The 2022 Global Hunger Index (GHI) revealed a severe hunger level in Tanzania [15]. To ensure resilience and sustainability in (greening of) the sorghum value chain, there have been efforts and recognized improvements, such as adopting hybrid high-yielding seed varieties, conservation agriculture, climate-smart agriculture, etc., made by public, private, and development institutions. Despite the release in the 1980s of the Macia, Tegemeo, and Pato sorghum hybrid seed varieties, the sorghum value chain still faces various challenges that result in low production [16]. The greening approach ensures environmental (and climate change) stewardship and economic incentives.

Agricultural expansion, unsustainable land use practices, climate change, and institutional barriers such as lack of input in financing innovations (including loans) and limited markets are highlighted in Chevallier et al. [17], coupled with low adoption of environmental sustainability agricultural technologies. Kaliba et al. [18] explore some of the leading causes for declining sorghum productivity and food security. Planting poor quality seeds, low or non-use of fertilizers, and planting methods significantly affect productivity. According to Mrema et al. [5], a lack of knowledge about improved agronomic practices, such as row planting, is a significant limiting factor for sorghum production in the project area, i.e., the Meatu and Kishapu districts. This is because farmers in the two districts mainly use the 'song mbele' planting technique, which involves hand broadcasting seeds.

In addition, limited improved seed accessibility, resistance to pests, markets, and affordability limit the adoption of improved seed varieties [19]. Promoting improved technologies alone (including seed varieties) without ensuring sustained adoption will not bring about a turnaround in sorghum production. Availability of improved seeds, adequate production knowledge, and extension services are critical to adopting technologies. According to Kaliba et al. [18], commercialized sorghum farming is still rare in Tanzania as unstructured marketing offers smallholder farmers low crop prices [20]. Having guaranteed and predictable markets in the sorghum value chain will mean securing better prices and incentives for farmers to adopt improved technologies. To merge competitive marketing and promote the commercialization of sorghum, farmers require shielding from the adverse effects of climate shocks. There is a need to address land degradation, nurture and adopt good agronomic practices and climate-smart/greener technologies, and assure input and output market access. Tanzania has a readily available market for high-quality sorghum due to increased awareness of its health benefits, such as cancer prevention, reducing tumor incidence, and lowering blood pressure [21], and a growing export market demand among breweries [22]. According to Akpo et al. [23], about 95% (325,432 tons) of sorghum is purchased by traders, while processors buy 18,800 tons per year.

Despite the concerted efforts to promote sustainable sorghum farming in Tanzania, there is limited information on the sorghum value chain greening approaches in the Lake Zone Region. Furthermore, previous studies have highlighted the adoption of various production technologies and post-harvest management strategies. We found fragmented evidence regarding the greening of the sorghum value chain from input acquisition to marketing. Therefore, there is a need to highlight the sorghum value chain approaches in the Lake Zone Region from input acquisition to market for enhanced sustainability. This study aims to answer the following question: what is the role of the Lake Zone Smart Farms in developing a sustainable sorghum value chain in the Lake Zone Region of Tanzania?

## 2. The Greening Approach

Greening approaches are the processes of enhancing agricultural production while being cognizant of the need to protect the environment while promoting social benefits [24]. The process involves circular economy approaches that improve reuse, recycling, and recapture of value from input acquisition to manufacturing [25]. The concept of Competitive Advantage of a Nation by Porter [26] justified the importance of enhancing interconnected linkages in a value chain to enhance value. Porter [26] justified that different actors/activities in a value chain can be fine-tuned to enhance competitive advantage. Therefore, the concept of value chain greening could be defined as the process of fine-tuning different activities in the value chain stages from input acquisition to consumption to enhance competitive advantage and sustainability.

The project design and implementation utilized a resilient and sustainable food value chain (RSFVCD) approach [27]. The project mainstreamed climate change responses that promote resilience building and long-term sustainability in the value chain. This approach identifies/maps all the key actors in the sorghum value chain, their activities from input acquisition and production to final consumption, and the assorted value additions done to the product at each stage. Sorghum value chain actors were first mapped out: input suppliers, individual smallholder farmers, farmer groups, aggregators, local cereal grain retail and wholesale traders, off-takers, processors, extension service providers, agricultural officers, non-governmental organizations, financial institutions, and fabricators.

Kilimo Trust then identified partners (extension service providers and agro-dealers, off-takers, and input suppliers) to work within the targeted regions. See Figure 1 for a pictorial representation of the value chain stakeholders.

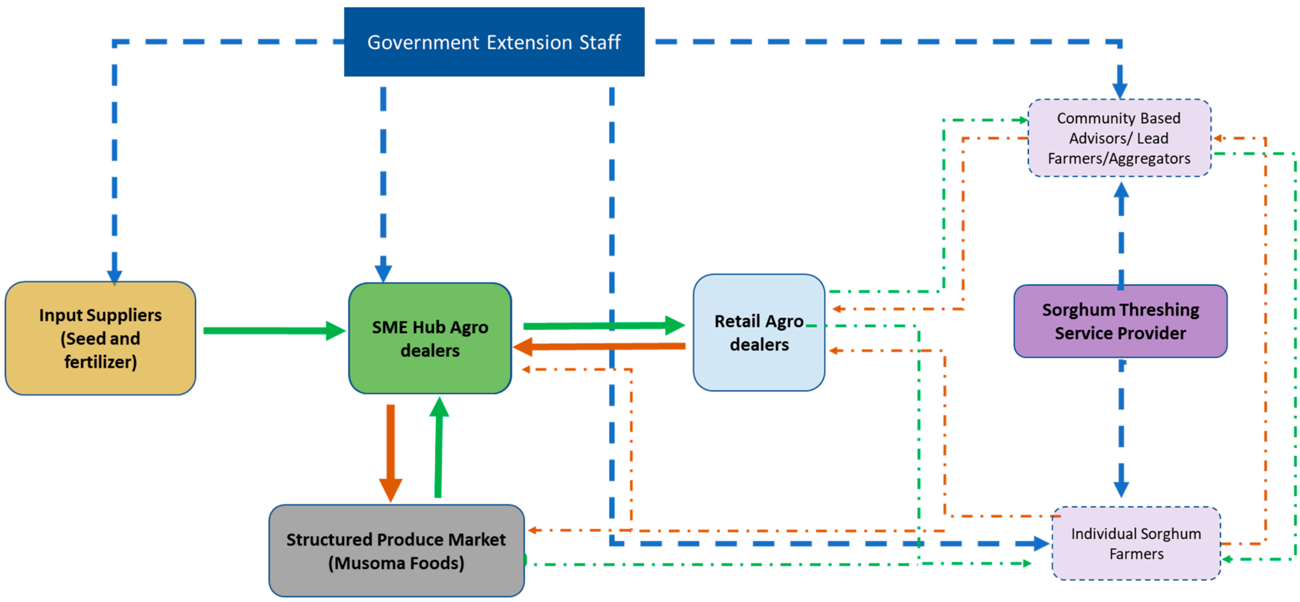


**Figure 1.** Sorghum value chain stakeholders' model in Tanzania. SME is an abbreviation for Small and Medium Enterprise.

The project design employed multi-stakeholder platforms (MSPs) as an entry point toward building a highly interactive stakeholder ecosystem/environment. The MSP convener was Kilimo Trust, a not-for-profit organization working on agriculture for development across the East African community. It was the lead partner/agent in the sorghum value chain greening design and implementation, including mobilization for an MSP setting under the aegis of the Lake Zone Smart Farms (LSF) Project.

## 3. Methodology

### *3.1. Project Area and Greening Evidence Collection*

The sorghum value chain greening project was implemented in three districts: Shinyanga, Kishavu in the Shinyanga region, and Meatu in the Simiyu region, which are all located within the Lake Zone of Tanzania (Figure 2). The study was conducted in the Shinyanga and Kishavu districts towards the end of the implementation of the sorghum greening Lake

Zone Smart Farms (LSF) Project Project led by Kilimo Trust, with support from AGRA and UNDP.

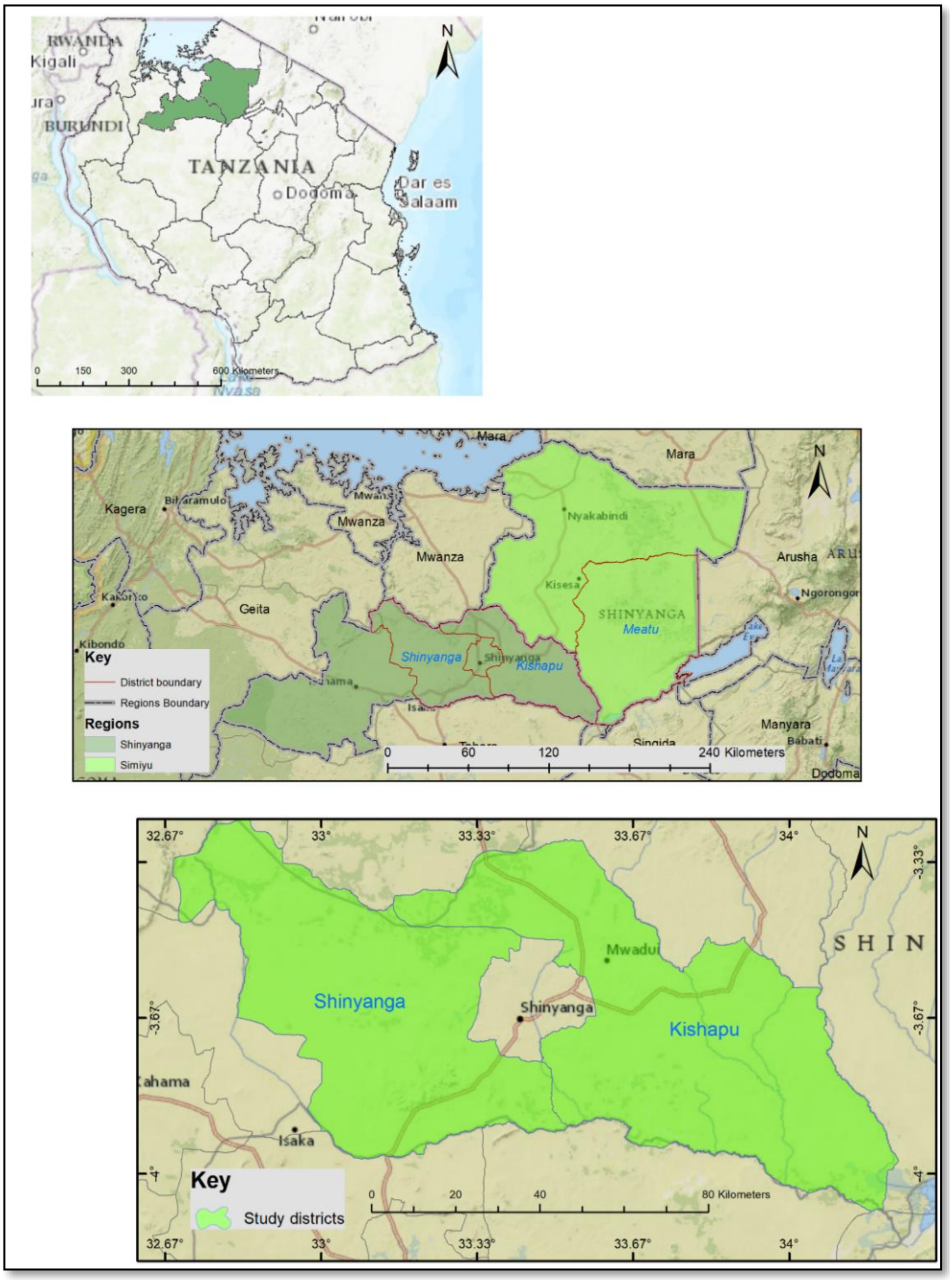


**Figure 2.** Maps showing the project area and study area.

Shinyanga lies at an altitude of 500 m to 2500 m with dissected and gently undulating rolling plains. According to Masuki and Mbogoni [23], the dominant soil is light-colored, coarse-textured, and with waterlogging characteristics (Eutric Planosols). The soils are susceptible to surface sealing/capping, soil erosion, low fertility, salinity, and sodicity [23]. The zone has an intermediate temperature regime with a 2 to 6 month length of the growing season. Major crop enterprises are rainfed cotton, sorghum, maize, tobacco, and groundnut, with pastoralism as the dominant livestock production system. Climatic constraints include erratic rainfall distribution, which poses a moderate to high drought risk for the rural farming community. We selected to work on the sorghum value chain because of climate change's increased effects on maize. Sorghum is drought tolerant and the preferred crop to grow in these areas. However, it has suffered neglect in research, development, and promotion. Therefore, this project aimed to promote the value chain that requires greening principles.

### 3.2. Data Collection

The task employed a multifaced approach, collecting quantitative and qualitative primary data through individual interviews. Secondary data were obtained from predominantly online project-related documents, reports, publications, and conference proceedings. Primary data were collected from key informant interviews (KII) with the value chain actors, i.e., agro-input suppliers, individual farmers, commodity aggregators, equipment fabricators, grain off-takers, extension officers, and the project implementing organization. The interview schedule included questions on demographic profile, sorghum production-promoted agronomic practices, input (seeds, fertilizers, pesticides) availability, post-harvest management practices, climate change awareness, markets, the limitations/challenges in sorghum production and marketing, and recommendations. The key informers were interviewed at their place of work, i.e., aggregation stores for aggregators, company headquarters for grain off-takers, shops for input suppliers, district headquarters for the extension officers, and farms for the farmers. During the interviews, audio recordings and notes were taken. Before interviewing each key informant, informed consent was obtained, and data were anonymously collected afterwards.

### 3.3. Analysis of the Collected Data and Quality Assurance

The audio recordings were transcribed and lengthy notes were summarized for ease of interview theme identification. Once all the notes were organized and the audio transcribed, all the data were reviewed for common themes or categories following the Gioia method [28]. The themes were noted, analyzed, and summarized. In addition, powerful quotes from the interviews were noted. The summarized themes were in the following categories: most common climate change-related themes that emerged throughout the interviews; the most common themes that emerged for each interview question; specific quotes or responses that support sorghum value chain resilience and sustainability; and an overall summary that captured the sorghum value chain's actors' thoughts, beliefs, and recommendations under the prevailing changing climate scenarios.

### 3.4. Summary Targets for the Kilimo Trust-Led Sorghum Greening Project

The number of smallholders and extension officers targeted by the project is presented in Table 1. Based on the targets, the project aimed to promote greening technologies to 15,000 smallholders, complete 300 extension events, facilitate 300 field days, and train 120 VBAs.

**Table 1.** The distribution of target smallholder farmers and extension officers in Tanzania.

| Variable | Year | |
|---|---|---|
| | 2021 | 2022 |
| Number of farmers to be reached with promoted interventions | 9000 | 6000 |
| Number of extension services events to be completed | 150 | 150 |
| Number of field days to be facilitated | 150 | 150 |
| Number of participants to be participating in AGRA-supported extension services | 6500 | 8500 |
| Number of new Village Based Advisors (VBAs) to be providing extension services to farmers | 60 | 60 |

### 3.5. Key Stakeholders and Expected Roles

This section highlights different actors' roles in the sorghum greening project (Table 2). The section highlights the value chain's key actors, including input suppliers, producers, aggregators, transporters, buyers, and consumers. Further, other supportive services such as employment creation, extension, and government interventions are presented.

**Table 2.** Key stakeholders and roles.

| # | Project Partners | Key Roles |
|---|---|---|
| 1 | Kilimo Trust | Coordinated the partners |
| 2 | Government (Ministry of Agriculture) | Selection and formation of Village Based Advisors (VBAs) |
| 3 | AGRA & UNDP | Provisions of extension services |
| 4 | Agro-dealers | Provision of inputs and offtaking |
| 5 | Fabricators | Manufacturing of fabricators |
| 6 | Musoma Foods Company Limited | The market for the sorghum |

## 4. Results and Discussion

### *4.1. Input Supply*

The project succeeded in linking agro-dealers (input suppliers) and farmers. The agrodealers supplied improved seeds and fertilizers. Additionally, they played a key role in the provision of advisory services on good agricultural practices, e.g., planting methods and pest management.

Johnson, an agro-dealer in Shinyanga, explained that…

*"…I have been selling sorghum seeds to the farmers, training the farmers as well as running crop demonstration plots. I also advise them on various good agricultural practices such as the required planting spacing, which should be 70 cm interrow by 25 cm, intra row with a plant population of 2–3 seeds per hill, and pest management. I supply them with the seeds to plant in the demo plots. Other farmers then visit the demo plots to learn why there are higher yields from the plots after planting seeds that resist droughts and diseases…"*

Among the promoted seed varieties, including Macia, Pato, and Serena, Macia had the highest market demand. However, the variety is prone to bird damage. The farmers preferred Macia because it is drought-tolerant, early maturing (60 days), high-yielding, and sweet to consume. However, due to the generally low sorghum production on the farms, the certified Macia seed supply was still low. Similarly, the seed prices were also in a continuous state of fluctuation. In addition to the seeds, agro-dealers sold mineral fertilizers, i.e., NPK, DAP, and Urea, to the farmers for use during sorghum production. Through project outreach promoting good and greening agricultural practices, the agro-dealers reported an increased sale of inputs, especially seeds.

Alice, a stockist, reported that;

*"… Each season since 2020/2021, I have sold about 2 tonnes. However, this year, we experienced seed challenges forcing smallholders to reuse the previous harvest and sell to their colleagues…"*

However, the farmers did not significantly use mineral fertilizers due to high costs. Robert, a farmer in Kashinje, affirmed that…

*"…he does not apply fertilizer because they are costly…"*

At the input stage, smallholders face challenges of timely input acquisition. First, the project highlighted a serious challenge in certified seed supply. The financial constraints among the agro-dealers and fluctuating market demands exacerbate the challenge. Smallholders' purchase of the seeds from fellow farmers hindered the uptake of the improved seeds. Notably, fertilizers were not readily available in the markets, limiting their utilization by smallholders.

### *4.2. Production*

The project supported the formalization/registration of the farmer groups. The groups provided easy access to technology providers and extension services to transfer knowledge for enhancing farm productivity.

Robert, the program manager of Kilimo Trust, pointed out that…

*"... the training was slightly below the target of 15,000. Slightly more than 12,000 farmers were trained on good agricultural practices (GAPs), climate-smart technologies, and post-harvest management practices ..."*

The training on climate-smart technologies included crop rotation using green grams, cover cropping, intercropping, waste recycling, zero/minimum tillage, and the use of improved seed varieties. As a result of implementing the project, particularly through the support of extension services, 13,523 out of the targeted 15,000 farmers were reached with the technologies. Approximately 201 hectares of land were put under the use of promoted and supported technologies. This suggested that the project reached 90% of the target farmers. A longer-term period is required to realize yield benefits from implementing climate-smart technologies, e.g., crop rotation and zero tillage [29].

As noted by the program manager, the project implementation period was not adequate to actualize the full results and impacts it intended;

*"....the project was implemented for only 18 months, thus for only one season. Unfortunately, the season was very dry, and banks hesitated to offer loans; therefore, realizing the benefits of technologies could have been hindered...."*

The promoted drought-tolerant sorghum varieties by the project were Macia, Tegemeo, Wahi, and Pato. Macia was the most preferred variety due to the advantages of early maturity and high productivity. Macia has been reported as early maturing by Orr et al. [2] and Mashingaidze et al. [30], and is a high-yielding sorghum variety [5]. However, it experienced high bird infestation and had limited seed supply. The promotion of the improved seed varieties was undertaken via demonstration plots. Drought-tolerant seeds enhance resilience in the sorghum value chain by ensuring increased food availability. Elias and Robert highlighted the importance of the Macia variety.

Elias, a farmer and chairperson of the Tumaini group, explained that,

*".....I have farmed the white variety of sorghum known as Macia. We started growing Macia last year after being trained by Kilimo Trust on land preparation, planting techniques, and spacing. The main challenge in farming the Macia variety is that it experiences high bird infestation. We formed the group and registered it with the help of Kilimo Trust... The training has been of great help to us in terms of production......."*

According to Robert Kashinje, a farmer, the Macia variety was a drought-tolerant variety.

*"...I have planted Macia sorghum because it is more drought tolerant than maize and also sweet for consumption...."*

Smallholders are faced with multiple challenges in the production of sorghum in Tanzania. Striga weeds highly infest sorghum. The weeds lower crop yields and quality. Bird menace is a significant drawback to sorghum production. Climate change, including low and poor rain distribution, significantly reduces sorghum productivity. When a farmer grows sorghum for two consecutive seasons without external inputs, the soil loses fertility, resulting in low yields.

### *4.3. Post-Harvest Management*

Proper post-harvest management is essential in maintaining and sustaining quality sorghum grains. Kilimo Trust provided technical assistance in training farmers on proper harvesting and storage through the farmers' groups that were either created or strengthened. At the end of 2022, 6401 households were utilizing the promoted post-harvest technologies/facilities such as sorting, drying, grading, and proper storage. Kilimo Trust, through the project, taught farmers how to use the threshing machine and improved storage bags. The improved storage bags are biodegradable and airtight. The bags limit the infiltration of pests, humidity, and other external elements that cause losses in grain. This technology, in turn, reduces the utilization of agrochemicals in the storage process of the grain. Limited utilization of agrochemicals reduces greenhouse gas emissions and lowers farmer expenses while maintaining grain quality. The predominant farmer practice of drying sorghum has been by directly placing it on the ground, exposing the grain to soil contamination, increasing the risk of pest infestation, and reducing the grain quality. Johnson Kasyoka, a stockist, and Daudi Mangiri, a fabricator, highlighted the success of the project in post-harvest management.

Johnson Kasyoka explained that. . .

*". . .I train farmers on pest control and proper storage. . .."*

The main challenge facing smallholders in sorghum post-harvest management is aflatoxin and grain losses due to poor timing of harvesting, rush to harvest, and poor storage by farmers, which lead to aflatoxin infection. The infestation by aflatoxin lowers the sorghum value and endangers consumers' health. However, there are concerted efforts to curb this problem by introducing training on harvest timing and storage. Storage facilities are also limited.

Yohanna, an aggregator, outlined limited storage facilities as a major challenge in post-harvest management of the crop:

*". . .. the only challenge is the [limited and inadequate] place to store such a granary. I ask [the] organizations to sponsor or build a granary for me, or they loan me to build my granary."*

Daudi Mangiri, a fabricator, asserted that

*". . .I train farmers to use machines to thresh their sorghum and dry their products fully and properly store them to reduce cases of aflatoxin. . .."*

Sorghum losses occur at different stages, including storage. There is limited access to innovative storage technologies. The available ones are in dilapidated condition [31]. Poor storage facilities provide a favorable environment for aflatoxin contamination [32]. Therefore, promoting mechanisms through improved physical infrastructure development lowers the risk of contamination and prevents post-harvest losses, which is vital in enhancing inclusivity, food security, and nutrition [33,34].

### *4.4. Aggregation*

Aggregation of farm produce is a practical approach for adding value for farmers and for developing the agriculture sector. Through aggregation centers, farmers get together to receive services or to sell their products [35]. Aggregation generates high efficiency in the sector and helps farmers meet market quality standards and requirements, thus enhancing their livelihoods. Aggregation of sorghum grain in the project area assured the availability of a market for farmers. The training on tarpaulins by Kilimo Trust reduced post-harvest losses, thus increasing quantities sold and transactions for the aggregators. A total of 7093 MT of sorghum yield was aggregated in 2022. The use of tarpaulins to dry the grain demonstrated a marked improvement in post-harvest crop quality and reduced losses. Thus, strengthening aggregation centers while at the same time establishing linkages of these aggregation centers to processors/buyers increases business volumes. Good post-harvest management practice, i.e., drying produce to the required moisture content, ensures improved product quality.

Yohana, an aggregator, revealed his relationship with Musoma foods and wholesalers,

*". . .. . .immediately I aggregated enough sorghum. I contact Musoma Foods [a local food processing company] or Emmanuel [a wholesaler], who sells in Nairobi, Kenya. . .."*

In addition, due to the assured markets, the aggregators can offer other services, such as loan facilities, to smallholder farmers. The loan is essential in ensuring proper storage; thus, higher quantities of good quality reach the market. Veda, an aggregator, reported the importance of market assurance in sorghum production:

*"…due to market assurance, farmers have gained confidence in me, and I can offer loans to farmers without a written contract, and they repay through selling their produce to me…"*

One of the main challenges in sorghum aggregation is storage. There are limited granaries to store the sorghum after aggregation. There is a need for increased financial and technical support in building granaries for the aggregators. This will enhance the availability of adequate storage and sustain the quality of sorghum grain.

Besides providing inputs to farmers, aggregators connect farmers to the market and can be used to help farmers synchronize their agronomic operations. The aggregators also link the farmer and quality markets [36]. Our findings corroborated with other models in promoting the sorghum value chain in Tanzania, where farmers gained access to mechanization, extension, inputs, and threshing services from the aggregators. However, the aggregation capacity is limited due to the low sorghum productivity [37].

### *4.5. Processing*

Various actors (aggregators and processors) are engaged in sorghum processing from the harvesting stage of the value chain—shelling, storage, and transportation. Shelling was reported as one of the main challenges for the farmers due to the limited availability of threshing/shelling services (machinery). Following full value chain mapping and analysis, the project created key linkages between fabricators (makers of shelling machines) and those willing to provide the service of shelling to facilitate the process where more farmers could access this service. Local manufacturers/fabricators of the shelling machines were directly linked to actors and farmers to sell or offer shelling as a service. Previously, before this service was offered, farmers would use traditional methods such as spreading the sorghum grain directly on the ground for drying. This method would thus be prone to dust accumulation and other impurities. After drying, shelling would be performed manually, leading to high losses and reduced grain quality. The use of shelling machines, therefore, ensures the maintenance of the quality of the produce. The fabricator explained that;

*"…In the beginning, the farmers did not acknowledge [appreciate] the use of machines, but with the project's intervention, the farmers now appreciate the use of shelling machines. With that, we have increased business in selling the machines and providing the service to the farmers…"*

There is a challenge of counterfeit low-quality shelling machines from fraudulent business people in the areas where the project operates. The low-quality machines produce poor-quality sorghum. This causes price distortions because their pricing is often below the actual market price of the services provided. Additionally, counterfeit devices reduce farmers' confidence in shelling services as the quality of service is usually poor, leading to reduced market prices for their produce. These challenges have led to the market suppression of threshing machines and services. Another challenge of operating locally fabricated threshing machines is the limited availability of maintenance capacities on the market. The machines break down very often, especially the ones imported from China. This increases the cost of operating the shellers, increasing the sorghum's pricing.

In terms of storage and transportation of the sorghum grain, one particular processor indicated that:

*"…they have 16 trucks that they use to pick produce from the farmers and aggregators. If the grains are not dry to the required moisture content, they must store it for some time…"*

In formal Tanzania smallscale production, surplus sorghum attracts the need for increased processing [38] of the grain into a diversity of products. Processing sorghum into various products provides additional income for value chain actors [39]. The main products from sorghum processing are snacks, precooked pasta, bread, beers, nonalcoholic drinks, modern convenient sorghum [and millet] food, and animal feed products [40]. To harness the full potential of the sorghum value chain, the use of improved technologies such as processing machines is essential. Buyers prefer clean, high-quality, and adequately dried sorghum for enhanced return and safety of machines [41]. However, there is a low rate of technology adoption for post-harvest processing among smallholder sorghum value chain actors in Tanzania [1]. Further, Kaliba et al. [18] established that institutional support systems such as capital financing availability are vital determinants of technology uptake and its continued adoption.

### *4.6. Marketing*

Limited access to competitive and predictable markets limits sorghum productivity and farmers' interest in improving the management of sorghum. Evidence and information from the project reported that 7093 MT of sorghum was sold through structured markets by the end of 2022 (Table 3). The farmers, agro-dealers, processors, and extension officers reported sorghum produced from the improved seed variety, i.e., Macia, had a readily available market.

**Table 3.** Target and actual achievement in the structured markets.

| Variable | Year | | | | Overall | | |
|---|---|---|---|---|---|---|---|
| | 2021 Target | Actual | 2022 Target | Actual | Total | Target | Achievement |
| Quantity (MT) of crops sold through structured markets | 9000 | 790 | 6000 | 6303 | 7093 | 1500 | 47% |
| Quantity (MT) of produce aggregated | 9000 | 790 | 6000 | 6303 | 7093 | 15,000 | 47% |
| Value of produce sold through structured markets | | 176,278 | | 561,939 | 738,217 | - | |
| Number of farmers selling produce through structured trading facilities/arrangements | 5000 | 761 | 2500 | 7388 | 8149 | 7500 | 109% |
| Value (USD) of focus crops sold through structured markets | 700,000 | 176,278 | 650,000 | 1,730,809 | 1,907,087 | 1,350,000 | 141% |
| Number of contracts signed with value chain actors | 7 | 7 | 2 | | - | 9 | |
| NRF: 69. Number of training events held to build capacity of farmers and other value chain actors along focus value chains | 20 | 210 | 10 | 93 | 303 | 30 | 1010% |
| NRF: 70. Number of individuals who have received AGRA-supported short-term agricultural sector training | 3000 | 844 | 1000 | 3589 | 4433 | 4000 | 111% |

Elias, a farmer, explained the importance of this variety in accessing markets:

> *"…white sorghum variety [Macia] has the readily available market, e.g., Musoma foods who buy at Tzshs 500–600 per kilo. Kilimo Trust enabled us to start a group called Tumaini, and they guided us to register it officially, and we have been farming sorghum. The markets are here in Shinyanga. Musoma foods buy from us. Kilimo Trust has helped us, and we see the benefits…"*

The data showed mixed results in the structured markets. The projected target of 15,000 MT was to be produced and sold through structured markets. However, only 47% of the target was achieved. The project surpassed the target in selling through agreements in terms of the value of USD sold, the number of training events held, and the number of individuals trained. However, despite setting targets for forward contracts, none were signed during the project implementation period. The agricultural officer explained that farmers were also trained in marketing;

> *"…Farmers were trained on market availability both locally and in neighboring countries [Uganda]. As a result, many of them decided to farm sorghum. As of now, sorghum is very marketable, with a 20 kg package being sold at TzShs 18,000–20,000. The market for sorghum in Kishapu is readily available [for consumption] within [the country] and*

*outside [Tanzania], e.g., Kenya, especially for the white variety. That is why we encourage the farmers to farm more [of] this variety due to market availability. . ..*"

There is a need for an external market. The processor, Musoma Foods, identified breweries as a major sorghum market;

"*. . . We realized there is a market for sorghum produce from the breweries, e.g., Tanzania breweries; thus, we looked for farmers in areas where sorghum can do well and made a contractual agreement with them as a way of assuring them market for their sorghum produce. . .. . .After assuring them of markets, the farmers agreed to farm sorghum in large quantities. we also get a ready market from the World Food Programme who, distribute to refugees.*"

The aggregator from Veda added that;

"*. . .I would ask that you support us and connect us to the larger market. . .*"

Contrary to that, Robert, the program manager, underscored the fluctuating prices in the market

"*. . .market prices for sorghum grain keep fluctuating, thus a disincentive towards resilient sorghum value chain since the farmers get discouraged. . ..*"

Sorghum marketing in Tanzania faces a myriad of challenges. Fluctuation of the price is a significant drawback in the sorghum value chain. There is a high inconsistency among farmers as they frequently shift from one crop to another. Training smallholders on the value of sorghum crops, price stabilization, and profitability is vital. Moreover, smallholders must be trained to handle sorghum production as a business. This can be achieved by registering groups for business offtaking companies such as Musoma Foods and others. The low quantity of sorghum produced is a key challenge in sorghum marketing. Additionally, due to poor sorghum storage by farmers, the sorghum gets infected by aflatoxin. If the aflatoxin exceeds recommended contamination levels, the sorghum loses its marketability.

One main challenge identified during project implementation in building resilient sorghum value chains was the limited accessibility of the improved seeds from the seed companies. In addition, using improved seeds, farmers have taken up conservation farming practices (zero tillage, cover crops, use of ridges) and planting in rows as agronomic practices that reduce labor costs and work towards preserving, enhancing, and managing soil health. Implementation of the project strengthened the linkage between the agro-input dealers and smallholders (Agro-Input-Production). However, the link between certified seed producers, i.e., seed merchants, breeders, farmer producers, and input distributors (agro-dealers), was weak under the project. This was similar to the link between extension service providers, seed merchants, and breeders. Thus, having a functional link between extension officers and seed producers would facilitate productivity feedback to the producers, as the extension officers would have a close working relationship with the smallholder farmers.

Farmers do not use fertilizers due to high costs. Thus, there is a need to ensure the availability of inputs at affordable prices for incorporation in implementing climate-smart technologies. Besides mineral fertilizers, farmers must capitalize and use readily available organic inputs, such as manure. This would lead to increased productivity, enhancing sustainable livelihoods. According to FAO [42], the use of manure delivers several benefits to farmers, such as improved food security and income, better nutrition, and greater resilience to climate stresses.

The study revealed that actors involved in post-harvest management (fabricators) had no link to the traders (wholesalers and retailers) (Figure 3). To ensure efficiency, linking the shelling service providers to the traders would provide access to the sellers efficiently, thus ensuring timely delivery for processors and consumers. There was no linkage between retailers and smallholders. The link is crucial as the retailers can easily reach the farmers within their locality. Additionally, the retailers can have enough stock because most farmers produce sorghum in low quantities. Financial providers' linkage to other actors (farmers, fabricators, wholesalers, retailers, millers) had not been actualized. Significant financial support is needed to adapt to the adverse effects and reduce the impacts of a changing climate [43].

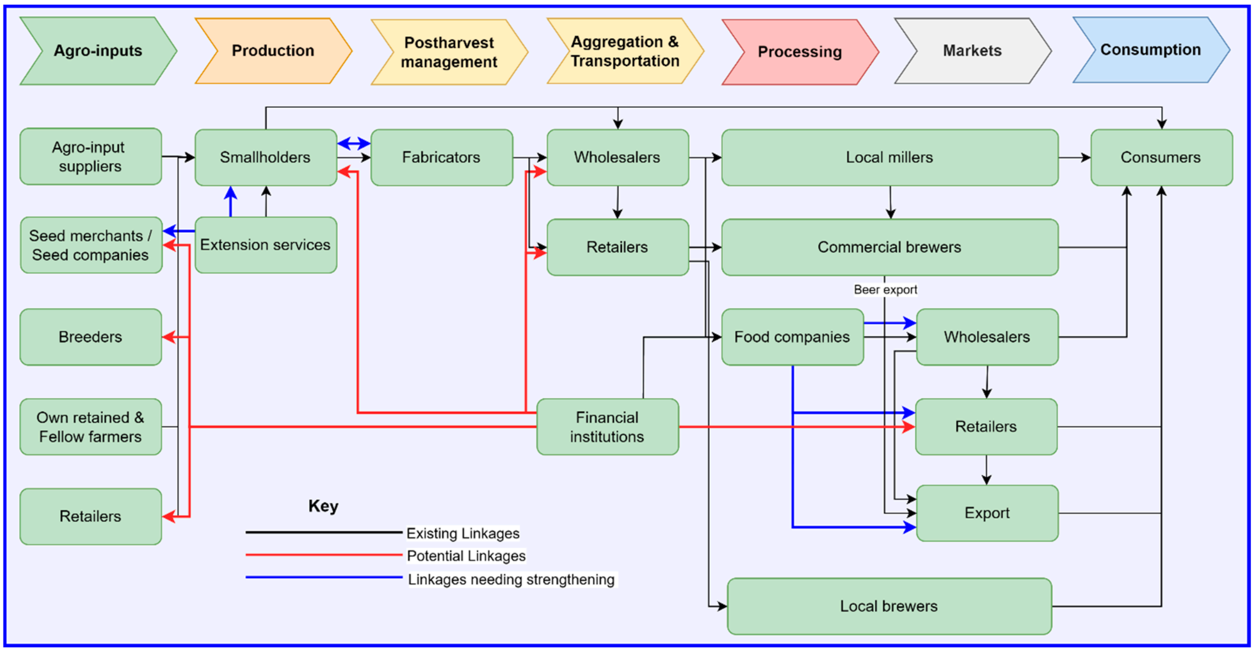


**Figure 3.** Map of the sorghum value chain in the Lake Zone of Tanzania.

The suggestion is to link different seed producers to input suppliers, extension service providers and seed merchants, breeders and retailer Stuckists, financial institutions, and all actors. The links that need strengthening are input dealers and farmers, fabricators and farmers, food companies and markets, and extension service providers and farmers.

The processor, Musoma Foods, indicated the project played a central role in preventing aflatoxin;

> *". . . ..Before the farmers were trained, many brought sorghum with aflatoxin, but the number has reduced after they were trained on how to store and prepare their sorghum. . . .."*

Except for food companies, e.g., Musoma Foods, the market linkage was weak between producers and sellers (especially big market players, e.g., brewers, wholesalers, and exporters). This could be attributed to the low productivity caused by climate change, thus not sufficient for contract buying. The smallholder selling through groups could be attributed to increased bargaining power and higher prices once bulk-farmed [1]. However, producing low-quality grain limits sorghum competitiveness in the local and international markets [22]. The leading causes of low sorghum grain quality include using traditional varieties, limited adoption of good agronomic practices, and poor post-harvest management that leads to aflatoxins [5,19]. Therefore, the greening process from inputs to processing could enhance the quality, quantity, and market-driven sorghum value chain.

### *4.7. Service Actors*

Ward and village agricultural/extension officers are crucial in promoting technologies. The officers encouraged farmers to take up sorghum farming by implementing demo plots using the improved seed varieties, i.e., *Macia* (preferred), *Wahi*, and *Tegemeo*. Farming sorghum crops was encouraged by the officers as it is drought tolerant. The officers also trained the farmers on climate-smart technologies such as using ridges, manure to conserve moisture and control striga, and good post-harvest management practices.

Maduhu, the agricultural officer in Kishapu, highlighted the shift from maize to sorghum farming in response to climate change;

*"....there has been a declining rainfall; thus, we have been encouraging farmers to plant sorghum compared to maize. This is because sorghum is drought-tolerant. More so, we encourage them to plant Macia seed variety. We encourage farmers to practice crop diversification, e.g., cotton. We also emphasize soil and water conservation practices, e.g., ridging and applying organic manure to control striga infestation ...."*

Aggregators offer an essential service to the value chain actors. They fabricate machinery for people who are involved in the threshing business. Machines play a key role in reducing post-harvest losses and labor requirements. This saves on cost and time.

Access to finance and credit can be a limiting factor in actualizing the full potential of crop value chains. Financial service providers and institutions cite uncertain markets, low capacity in record keeping, and limited understanding of the credit terms, among many, as restricting factors.

The program manager, Robert, from Kilimo Trust, explained the importance of the vagaries of climate change,

*"...... Youth groups aiming to purchase shelling machines and offer the service to farmers were linked to I & M Bank for financing. However, the linkage was unsuccessful due to uncertainty in productivity caused by climate change. This was also experienced in the linkage between farmers and the bank for loans......"*

The findings showed that extension service penetration to the smallholders was high (Table 4). The study reached 90% of the target smallholder farmers. Additionally, the achievement of the extension programs was high, except for the number of field days facilitated.

**Table 4.** Access to sorghum production information: extension and smallholders.

| Variable | 2021 | | 2022 | | | Overall | |
|---|---|---|---|---|---|---|---|
| | Target | Actual | Target | Actual | Total | Target | Ach * |
| Number of farmers reached with promoted interventions | 9000 | 9771 | 6000 | 3752 | 13,523 | 15,000 | 90% |
| Number of extension services events completed | 150 | 199 | 150 | 92 | 291 | 300 | 97% |
| Number of field days facilitated | 150 | - | 150 | 6 | 6 | 300 | 2% |
| Number of participants participating in AGRA-supported extension services | 6500 | 8887 | 8500 | 3752 | 12,639 | 15,000 | 84% |
| Number of new Village Based Advisors (VBAs) providing extension services to farmers | 60 | 31 | | 25 | 56 | 60 | 93% |

* Ach is Achievement.

Service actors play significant roles in greening the sorghum value chain. First, the government extension officers disseminate agricultural innovations to the farmers [44]. However, limited government extension agents need enhanced mechanisms for reaching smallholders. Different extension models have been developed in Tanzania to enhance information dissemination to farmers. Similar to our study, the literature showed that some of the mechanisms designed for extension include lead farmers, training of trainers (ToTs), and village-based advisors [45–47]. Poverty and limited access to financial support limit the adoption of innovations. Similar to our study findings, Kimbi et al. [45] suggested that financial credit influences the adoption of agricultural innovation such as contract farming and improved varieties.

## 5. Conclusions and Recommendations

Building resilient crop value chains should involve the creation of partnerships with all stakeholders (public, private, and civil society) to verify and evaluate the inherent trade-offs involved in the new roles for the stakeholders and the measurement metrics required for tracking environmental performance. The sorghum value chain's potential for resilience and sustainability was positively facilitated by the collaborations between the smallholder farmers, the private sector, BDS (support service) providers, and governments.

The involvement of different actors in the sorghum value chain increased the potential for agribusiness growth of the sorghum value chain. For example, the processor reported that due to market assurance to the farmers and training on good agricultural practices conducted by the project, there had been an increase in sorghum volumes supplied to the processor. Sorghum production increased due to utilizing improved seed variety, specifically *Macia,* and practicing good agricultural practices. Using demo plots as a training ground for the farmers facilitated the adoption of the promoted good farming practices. For instance, many actors (farmers, agro-dealers, and aggregators) acknowledged the importance of planting the Macia seed variety, describing it as drought-tolerant, sweet to consume, and desirable on the market, especially to the breweries. Higher yields result in increased incomes per household from the sale of surplus produce. Provision of training and extension services enhanced post-harvest management and crop quality. Strengthened aggregation centers through assured markets and provision of post-harvest handling equipment eliminate market uncertainty, thus ensuring farmers' access to financial services.

Outscaling the drought-tolerant seed varieties is highly recommended due to their high drought tolerance and readily available markets locally, regionally, and internationally. To enhance adoption and resilience in sorghum production, climate-smart technologies need to be implemented, e.g., conservation tillage and crop rotation, in a longer-term period to realize their impacts and adoption by the farmers. In addition, there is a need to promote readily available organic inputs, e.g., manure, since mineral fertilizers are costly for farmers. The government could also enhance this by availing more certified seeds to farmers through free seed packs. Based on the findings, we highlight the following policy recommendations. There is a need for policies to be sensitized to the value chain actors. For instance, the government should look into policies hindering private sectors from participating in seed production due to limited seed availability.

Further, the extension officers and trainers would need to be trained on value chain greening. Secondly, climate change adaptation policies should strengthen the linkage between farmers and other value chain actors. Thirdly, policymakers should consider establishing an agricultural financial kit and gender mainstreaming to enhance climate change. Women and youth are the primary agriculture labor providers. However, their involvement in the project was not visible. Building resilience in a crop value chain under smallholder rain-fed farming systems in developing countries, e.g., Tanzania, requires inclusiveness, i.e., gender mainstreaming/inclusion and integrating other technologies such as small-scale irrigation and, where possible, other yield-enhancing technologies.

## 6. Limitations of the Study and Areas of Further Research

The study used a qualitative approach. Therefore, quantitative data on actual gains across different value chain actors are not presented. The study focuses on the sorghum value chain's actors' opinions regarding greening approaches. This includes actors in input acquisition, production harvest, post-harvest management, aggregation, off-taking, and marketing and support services. However, the study does not collect quantitative data on the adoption levels and monetary benefits of the greening approaches for each actor. Therefore, future quantitative studies are needed to highlight the adoption levels and benefits associated with sorghum value chain greening in Tanzania.

**Author Contributions:** Conceptualization, A.N., M.S. and F.N.; methodology, F.N., C.M.M. and M.K.; software, F.N., C.M.M. and M.K.; validation, F.N., C.M.M. and M.K.; formal analysis, F.N., C.M.M. and M.K.; investigation, A.N., M.S., F.N., C.M.M. and M.K.; resources, A.N., M.S. and T.S.; data curation, F.N., C.M.M. and M.K.; writing-original draft preparation, F.N., C.M.M., M.S. and M.K.; writing-review and editing, A.N., M.S., F.N., C.M.M. and M.K.; visualization, F.N., C.M.M., M.S. and M.K.; supervision, A.N. and M.S.; project administration, A.N., M.S., T.S. and F.N.; funding acquisition, A.N., M.S. and T.S. All authors have read and agreed to the published version of the manuscript.

**Funding:** AGRA: Nairobi, Kenya, and United Nations Development Programme, Pretoria, South Africa.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** Data is contained within the article.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the study's design, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

## References

1. Kalema, E.P.; Akpo, E.; Muricho, G.; Ringo, J.; Ojiewo, C.O.; Varshney, R.K. Mapping out market drivers of improved variety seed use: The case of sorghum in Tanzania. *Heliyon* **2022**, *8*, e08715. [CrossRef] [PubMed]
2. Orr, A.; Schipmann-schwarze, C.; Gierend, A.; Nedumaran, S.; Mwema, C.; Muange, E. Why invest in Research & Development for sorghum and millets? The business case for East and Southern Africa. *Glob. Food Secur.* **2020**, *26*, 100458. [CrossRef]
3. FAOSTAT. *Food and Agriculture Organization, Statistics Division*; FAOSTAT: Morogoro, Tanzania, 2023.
4. FAOSTAT. *FAOSTAT Statistical Database*; FAO (Food and Agriculture Organization of the United Nations): Rome, Italy, 2021; Available online: https://www.fao.org/faostat/en/ (accessed on 1 May 2023).
5. Mkonda, M.Y. Environmental and Sustainability Indicators The underway to pragmatic implementations of sustainable and intensive agricultural systems in Tanzania. *Environ. Sustain. Indic.* **2021**, *11*, 100117. [CrossRef]
6. Mrema, E.; Shimelis, H.; Laing, M.; Bucheyeki, T. Farmers' perceptions of sorghum production constraints and Striga control practices in semi-arid areas of Tanzania. *Int. J. Pest Manag.* **2017**, *63*, 146–156. [CrossRef]
7. Kadigi, I.L.; Richardson, J.W.; Mutabazi, K.D.; Philip, D.; Bizimana, J.; Mourice, S.K.; Waized, B. Forecasting yields, prices and net returns for main cereal crops in Tanzania as probability distributions: A multivariate empirical (MVE) approach. *Agric. Syst.* **2019**, *180*, 102693. [CrossRef]
8. Mwamahonje, A.; Saviour, J.; Eleblu, Y.; Ofori, K.; Deshpande, S. Sorghum Production Constraints, Trait Preferences, and Strategies to Combat Drought in Tanzania. *Sustainability* **2021**, *13*, 12942. [CrossRef]
9. Mbululo, Y.; Nyihirani, F. Climate characteristics over Southern highlands Tanzania. *Atmos. Clim. Sci.* **2012**, *2*, 454–463. [CrossRef]
10. World Bank. The World Bank Group. Climate Change Knowledge Portal—For Development Practitioners and Policy Makers: Tanzania Dashboard Climate Baseline. 2017. Available online: https://climateknowledgeportal.worldbank.org/ (accessed on 10 March 2023).
11. McSweeney, C.; New, M.; Lizcano, G. UNDP Climate Change Country Profiles: Tanzania. 2010. Available online: https://www.climatelearningplatform.org/undp-climate-change-country-profiles-tanzania (accessed on 10 March 2023).
12. Adhikari, U.; Nejadhashemi, A.P.; Woznicki, S.A. Climate change and eastern Africa: A review of impact on major crops. *Food Energy Secur.* **2015**, *4*, 110–132. [CrossRef]
13. USAID. Tanzania Climate Vulnerability Profile. 2012. Available online: https://www.climatelinks.org/sites/default/files/asset/document/tanzania_climate_vulnerability_profile_jan2013.pdf (accessed on 10 March 2023).
14. Andiku, C.; Shimelis, H.; Shayanowako, A.I.T.; Gangashetty, P.I.; Manyasa, E. Genetic diversity analysis of East African sorghum (*Sorghum bicolor* L. Moench) germplasm collections for agronomic and nutritional quality traits Core ideas. *Heliyon* **2022**, *8*, e09690. [CrossRef]
15. Gram, G.; Roobroeck, D.; Vanlauwe, B. Combining organic and mineral fertilizers as a climate smart integrated soil fertility management practice in sub-Saharan Africa: A meta-analysis. *PLoS ONE* **2020**, *15*, e0239552. [CrossRef]
16. GHI. Global Hunger Index 2022: Tanzania. Available online: https://www.globalhungerindex.org/pdf/en/2022/Tanzania.pdf (accessed on 7 June 2023).
17. Mgonja, M.A.; Chandra, S.; Gwata, E.T.; Obilana, A.B.; Monyo, E.S.; Rohrbach, D.D.; Saadan, H.M. Improving the efficiencies of national crop breeding programs through region-based approaches: The case of sorghum and pearl millet in southern Africa. *J. Food Agric. Environ.* **2005**, *3*, 124–129. Available online: http://oar.icrisat.org/3199/ (accessed on 19 July 2023).
18. Chevallier, R.; Neely, C.; Chesterman, S.; Gosling, A.; Osena, J.J.; Muwaya, S. *Strengthening the Enabling Environment for Sustainable and Climate-Smart Land Management in Africa: Country Initiatives of the Resilient Food Systems Programme*; FAO: Rome, Italy, 2022. [CrossRef]
19. Kaliba, A.R.; Gongwe, A.G.; Mazvimavi, K.; Yigletu, A. Impact of adopting improved seeds on access to broader food groups among smallscale sorghum producers in Tanzania. *Sage Open* **2021**, *11*, 2158244020979992. [CrossRef]
20. Kaliba, A.R.; Mazvimavi, K.; Gregory, T.L.; Mgonja, F.M.; Mgonja, M. Factors affecting adoption of improved sorghum varieties in Tanzania under information and capital constraints. *Agric. Food Econ.* **2018**, *6*, 18. [CrossRef]
21. Kalema, E.P.; Kimbi, T.; Akpo, E.; Kongola, E.; Alexander, G.; Nzunda, J.; Okori, P.; Ojiewo, C. Brewery Industry-Led Seed Sector Development for Sorghum in Tanzania. 2022. Available online: http://oar.icrisat.org/id/eprint/12024 (accessed on 12 July 2023).
22. Saleh, A.S.; Zhang, Q.; Chen, J.; Shen, Q. Millet grains: Nutritional quality, processing, and potential health benefits. *Compr. Rev. Food Sci. Food Saf.* **2013**, *12*, 281–295. [CrossRef]

23. Akpo, E.; Kalema, E.; Kongola, E.; Muricho, G.; Ojiewo, C. Building Sorghum Seed Sector along the Grain Market in Tanzania: Areas for Policy Support. 2022, Policy Brief. Available online: http://oar.icrisat.org/12020/ (accessed on 27 June 2023).
24. De Marchi, V.; Di Maria, E.; Ponte, S. The greening of global value chains: Insights from the furniture industry. *Compet. Chang.* **2013**, *17*, 299–318. [CrossRef]
25. Winans, K.; Kendall, A.; Deng, H. The history and current applications of the circular economy concept. *Renew. Sustain. Energy Rev.* **2017**, *68*, 825–833. [CrossRef]
26. Porter, M.E. *Competitive Advantage of Nations: Creating and Sustaining Superior Performance*; Simon and Schuster: New York, NY, USA, 2011.
27. Masuki, K.F.G.; Mbogoni, J. *Agro-Ecological Zones of the Lake Zone, Tanzania*; Agricultural Research Institute (ARI): Tanga, Tanzania, 2016. [CrossRef]
28. Ahsan, M.B.; Leifeng, G.; Safiul Azam, F.M.; Xu, B.; Rayhan, S.J.; Kaium, A.; Wensheng, W. Barriers, Challenges, and Requirements for ICT Usage among Sub-Assistant Agricultural Officers in Bangladesh: Toward Sustainability in Agriculture. *Sustainability* **2022**, *15*, 782. [CrossRef]
29. AGRA; UNDP. Training Manual for Resilient and Sustainable Food Value Chain Development in Africa. 2020. Available online: https://www.resilientfoodsystems.co/assets/resources/pdf/rsfvc-training-manual-en-final-(2).pdf (accessed on 25 July 2023).
30. Mupangwa, W.; Twomlow, S.; Walker, S. Reduced tillage, mulching and rotational effects on maize (*Zea mays* L.), cowpea (*Vigna unguiculata* (Walp) L.) and sorghum (*Sorghum bicolor* L. (Moench)) yields under semi-arid conditions. *Field Crops Res.* **2012**, *132*, 139–148. [CrossRef]
31. Abass, A.B.; Ndunguru, G.; Mamiro, P.; Alenkhe, B.; Mlingi, N.; Bekunda, M. Post-harvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania. *J. Stored Prod. Res.* **2014**, *57*, 49–57. [CrossRef]
32. Mashingaidze, N.; Madakadze, C.; Twomlow, S.; Nyamangara, J.; Hove, L. Crop yield and weed growth under conservation agriculture in semi-arid Zimbabwe. *Soil Tillage Res.* **2012**, *124*, 102–110. [CrossRef]
33. Beta, T.; Ndolo, V.U. Post-harvest technologies. In *Sorghum and Millets*; AACC International Press: Washington, DC, USA, 2019; pp. 69–84.
34. Ngowi, E.R.; Selejio, O. Post-harvest loss and adoption of improved post-harvest storage technologies by smallholder maize farmers in Tanzania. *Afr. J. Econ. Rev.* **2019**, *7*, 249–267. Available online: https://www.ajol.info/index.php/ajer/article/view/182561 (accessed on 25 July 2023).
35. Awuchi, C.G.; Amagwula, I.O.; Priya, P.; Kumar, R.; Yezdani, U.; Khan, M.G. Aflatoxins in foods and feeds: A review on health implications, detection, and control. *Bull. Environ. Pharmacol. Life Sci.* **2020**, *9*, 149–155.
36. Orr, A.; Gierend, A.; Choudhary, D. Value Chains for Sorghum and Millets in Eastern and Southern Africa: Priorities for the CGIAR Research Program for Dryland Cereals (No. 42) 2017. Socioeconomics Discussion Paper Series. Available online: https://core.ac.uk/download/pdf/219474866.pdf (accessed on 14 March 2023).
37. Rao, B.D. Sorghum value chain for food and fodder security. In *Breeding Sorghum for Diverse End Uses*; Woodhead Publishing: Sawston, UK, 2019; pp. 409–419. Available online: https://tapipedia.org/content/sorghum-value-chain-food-and-fodder-security (accessed on 5 June 2023).
38. Nchanji, E.B.; Lutomia, C.K.; Chirwa, R.; Templer, N.; Rubyogo, J.C.; Onyango, P. Immediate impacts of COVID-19 pandemic on bean value chain in selected countries in sub-Saharan Africa. *Agric. Syst.* **2021**, *188*, 103034. [CrossRef] [PubMed]
39. Makindara, J.; Mpagalile, J.J.; Ballegu, W. Economic Analysis of Small Scale Sorghum Processing in Dar es Salaam, Tanzania. 2010. Available online: https://core.ac.uk/download/pdf/18199896.pdf (accessed on 3 February 2023).
40. Rao, E.J.; Mtimet, N.; Twine, E.; Baltenweck, I.; Omore, A. Farmers' preference for bundled input–output markets and implications for adapted dairy hubs in Tanzania—A choice experiment. *Agribusiness* **2019**, *35*, 358–373. [CrossRef]
41. Alavi, S.; Mazumdar, S.D.; Taylor, J.R. Modern convenient sorghum and millet food, beverage and animal feed products, and their technologies. In *Sorghum and Millets*; AACC International Press: Washington, DC, USA, 2019; pp. 293–329. Available online: http://oar.icrisat.org/11278/1/Modern%20Convenient%20Sorghum%20and%20Millet%20Food%2C%20Beverage%20and%20Animal%20Feed%20Products.pdf (accessed on 20 June 2023).
42. Ndossi, J.; Kalema, E.P.; Kimbi, G.T.; Akpo, E.; Kongola, E.; Ringo, J.; Makoye, L.Y.; Gekanana, R.; Waithira, G.; Ojiewo, C.O.; et al. *Harnessing Opportunities for Informed Investments in the Sorghum Commodity Value Chain in Tanzania: A Business Case*; Working Paper Series No. 5; CGIAR Research Program on Grain Legumes and Dryland Cereals, and International Crops Research Institute for the Semi-Arid Tropics (ICRISAT): Hyderabad, India, 2021; p. 69. Available online: http://oar.icrisat.org/11978/1/Harnessing%20Opportunities%20for%20Informed_Sorghum_Tanazania_WPS%205.pdf (accessed on 20 July 2023).
43. FAO. *Coping with Climate Change—The Roles of Genetic Resources for Food and Agriculture*; FAO: Rome, Italy, 2015; pp. 1–130. Available online: https://reliefweb.int/sites/reliefweb.int/files/resources/a-i3866e.pdf (accessed on 22 March 2023).
44. International Financial Reporting Standards (IFRS). Effects of Climate-Related Matters on Financial Statements. 2020. Available online: https://www.ifrs.org/content/dam/ifrs/supporting-implementation/documents/effects-of-climate-related-matters-on-financial-statements.pdf (accessed on 22 March 2023).
45. Lindahl, J.F.; Young, J.; Wyatt, A.; Young, M.; Alders, R.; Bagnol, B.; Kibaya, A.; Grace, D. Do vaccination interventions have effects? A study on how poultry vaccination interventions change smallholder farmer knowledge, attitudes, and practice in villages in Kenya and Tanzania. *Trop. Anim. Health Prod.* **2019**, *51*, 213–220. [CrossRef]

46. Morgan, S.N.; Mason, N.M.; Maredia, M.K. Lead-farmer extension and smallholder valuation of new agricultural technologies in Tanzania. *Food Policy* **2020**, *97*, 101955. Available online: https://www.sciencedirect.com/science/article/pii/S0306919220301597 (accessed on 15 March 2023). [CrossRef]
47. Gioia, D.A.; Corley, K.G.; Hamilton, A.L. Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organ. Res. Methods* **2013**, *16*, 15–31. [CrossRef]