Integrated Agricultural Development Strategies: Assessing Forage and Seed Supply Chain Dynamics at Vikuge Pasture Seed Farm, Kibaha, Tanzania

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Abstract
This study investigated the integrated agricultural development practices at Vikuge Pasture Seed Farm in Kibaha, Tanzania, focusing on the supply and commercialization of forage and seeds. It identified critical challenges that hampered effective commercialization and sought to elucidate how the farm's practices influenced local agricultural dynamics. Utilizing a mixed-methods approach, data were collected from 96 respondents through key informant interviews and focus group discussions, supplemented by a thorough literature review. A market system and value chain approach were adopted to analyze the flow of inputs from production to consumption, aiming to uncover the interconnected activities that enhance economic viability. Statistical findings revealed a remarkable 25% increase in annual revenue attributed to innovative agronomic practices and market-oriented strategies, underscoring the strong economic feasibility of the farm's operations. Qualitative insights from the focus group discussions highlighted the socio-economic implications of integrated practices, indicating improved access to high-quality forage seeds, enhanced livestock productivity, and positive ripple effects on local economies. Participants reported increased income and job creation, validating the transformative potential of integrated agricultural development initiatives. This study not only contributes to the understanding of

commercialization strategies in Tanzanian agriculture but also provides empirical support for policy frameworks aimed at promoting sustainable agricultural practices that can elevate local livelihoods and economic resilience. **Keywords:** Integrated agricultural development, forage and seeds production, livestock keeping development, Vikuge Pasture Seed Farm, Sustainable Economic Development.

1.0 Introduction

Tanzania's livestock sector, despite having the third-largest livestock population in Africa, contributes only 7.4% to the country's GDP (Michael et al., 2017). The sector's growth is hindered by low reproductive rates, high mortality, and disease prevalence (Michael et al., 2017). Livestock production accounts for about 30% of the Agricultural GDP, with beef, milk, and poultry each contributing approximately 30-40% (Rutabanzibwa, 2003). Despite these challenges, studies have shown that the livestock subsector has the highest contributive effect on economic growth compared to crop and fishery subsectors (URT, 2018; Mtaturu, 2020). Overall, agriculture contributes 25.88% to Tanzania's economy, with livestock accounting for 4.70% (Chongela, 2015). The 4.7 percent refers to the share of Tanzania's total GDP contributed specifically by the livestock subsector, as reported by Chongela (2015). Although livestock contributes approximately 30 percent of agricultural GDP, its share of the overall national GDP is lower, at 4.7 percent. This discrepancy arises because agriculture is a part of the broader economy, and livestock is just one segment within agriculture. Therefore, while livestock has a substantial impact within agriculture, its contribution appears smaller when viewed in the context of the total economy. As such, to improve the sector's performance, researchers suggest implementing a comprehensive livestock master plan (Michael et al., 2017) and reallocating more resources to the livestock subsector (NBS, 2019; Mtaturu, 2020), which could significantly boost agricultural production and economic growth in Tanzania.

Forage, which primarily consists of plant leaves and stems consumed by grazing livestock, serves as the cornerstone of the global livestock sector (Wilkinson and Lee, 2018). The importance of forage in sustaining livestock populations cannot be overstated. It serves as a primary source of nutrition for grazing animals, providing essential nutrients required for their growth, reproduction, and overall well-being (Wilkinson and Lee, 2018). Moreover, forage plays a crucial role in maintaining soil health and preventing erosion in grazing areas, contributing to the overall sustainability of livestock production systems (Wilkinson and Lee, 2018). In Tanzania, where the livestock sector plays a significant role in the economy and livelihoods of millions of people, the optimization of forage production and management is imperative for enhancing productivity, resilience, and sustainability in livestock farming systems (URT, 2018; NBS, 2019).

The productivity of Tanzania's livestock sector has been hampered by poor nutrition, primarily due to insufficient quantity and quality of forage available (Mganga et al., 2020). Within Tanzania, three primary livestock production systems prevail: traditional extensive production, intensive or commercialized systems, and semi-intensive production (Niwagaba et al., 2019). The traditional extensive system, which depends on communal grazing practices in natural pastures, encompasses over 96% of Tanzania's ruminant livestock population, with only a small fraction being raised under intensive commercial systems (NBS, 2019). In traditional extensive systems, livestock are largely left to graze on communal lands, often characterized by limited forage resources and insufficient nutritional intake, leading to suboptimal productivity (Niwagaba et al., 2019). Conversely, intensive or commercialized systems involve controlled feeding regimes and improved forage management practices aimed at maximizing livestock productivity (Niwagaba et al., 2019). However, such systems are less prevalent due to challenges related to land availability, input costs, and infrastructure (NBS, 2019).

Improving forage availability and quality is essential for enhancing livestock productivity across all production systems in Tanzania. This necessitates interventions focused on sustainable forage production, preservation, and utilization, as well as promoting the adoption of improved forage management practices among livestock farmers (Mganga et al., 2020; Niwagaba et al., 2019). Additionally, there is a need for targeted policies and investments to support the transition towards more intensive and commercially oriented livestock production systems, which can contribute significantly to the overall economic development of the country (NBS, 2019). Ruminant livestock producers in Tanzania typically fulfill their feed requirements through a combination of grazing, crop residues, planted forage, and other collected or purchased feeds (NBS, 2019). However, the accessibility to high-quality forage remains restricted, further compounded by climate change-induced variations in both availability and quality (UNDP, 2020). Seasonal fluctuations frequently result in insufficient feed supply during dry periods, which directly affects milk availability and prices, disproportionately impacting smallholder farmers (Mganga et al., 2020).

The vulnerability of smallholder farmers to forage scarcity underscores the urgent need for interventions aimed at enhancing forage availability and resilience to climatic variability. Implementing sustainable forage management practices, such as conservation agriculture and agroforestry, can mitigate the impacts of climate change on forage production and ensure more reliable feed supply throughout the year (UNDP, 2020; Mganga et al., 2020). Moreover, promoting the cultivation of drought-tolerant forage species and facilitating access to improved forage seeds can further bolster the resilience of livestock production systems to climate-related challenges (Mganga et al., 2020). In addition to climate-smart agricultural practices, targeted investments in irrigation infrastructure and water management initiatives can help buffer the effects of seasonal forage shortages,

particularly in arid and semi-arid regions (UNDP, 2020). Strengthening extension services and farmer education programs on sustainable forage production and utilization practices is also essential for building the adaptive capacity of livestock farmers and improving overall productivity (NBS, 2019). By addressing these critical gaps in forage availability and resilience, Tanzania can enhance the livelihoods of smallholder farmers, promote food security, and contribute to the sustainable development of its livestock sector.

Established initially as a crop and multiplication farm, Vikuge Pasture Seed Farm underwent a strategic shift to focus on pasture seed production in 1990 in response to challenges in meeting animal feed requirements (Urio, 2015). Since then, the farm has operated effectively, emerging as a significant supplier of pasture seeds and hay to livestock keepers across various regions in Tanzania (Mannetje, 2014). However, there exists a notable knowledge gap among smallholder farmers regarding the Vikuge Pasture Seed Farm, hindering their access to pasture crop seeds (Njau, 2000). Initiatives aimed at providing training to smallholder farmers in the Vikuge village seek to bridge this gap by increasing awareness and knowledge of pasture production, thereby improving seed availability and fostering livestock development in the Kibaha district. Expanding the dissemination of information about Vikuge Pasture Seed Farm and its benefits for smallholder farmers is crucial for ensuring equitable access to high-quality pasture seeds. Collaborative efforts involving agricultural extension services, local authorities, and community-based organizations can play a pivotal role in organizing training sessions and outreach programs to educate farmers about the benefits of utilizing improved pasture seeds from Vikuge Pasture Seed Farm (Urio, 2015). Moreover, establishing demonstration plots or field days at the farm can provide farmers with practical insights into pasture seed production techniques and the performance of different seed varieties under local conditions (Mannetje, 2014). By empowering smallholder farmers with the

knowledge and resources needed to enhance their forage production capabilities, Vikuge Pasture Seed Farm can significantly contribute to the sustainable development of livestock farming in the region.

With the objective of assessing the commercial viability of forage and seeds at Vikuge Pasture Seed Farm in Kibaha, Tanzania, this study aimed to probe into various aspects of the forage markets. Commercial viability in this context refers to the feasibility and profitability of producing and selling forage and seeds at Vikuge Pasture Seed Farm in Kibaha, Tanzania. As such, the study assessed whether the forage and seed products could succeed in the market by examining various aspects of the forage market system, such as production volumes, trends, and commercialization. It was sought to map out the complex dynamics of the forage market, analyze past production volumes and trends, investigate historical production, preservation, and commercialization practices, pinpoint systemic bottlenecks, and propose strategies for enhancing the overall performance of the forage industry (Niwagaba et al., 2019). Through doing so, it aspired to bolster the availability, accessibility, and affordability of forage to smallholder dairy farmers across Tanzania, thus promoting sustainable livestock production practices and ultimately uplifting livelihoods within the sector (Mganga et al., 2020; UNDP, 2020).

The findings of this study are anticipated to shed light on the historical evolution and challenges faced by the forage industry in Tanzania, offering valuable insights for policymakers, researchers, and practitioners alike. By identifying key areas for improvement and recommending targeted interventions, the study aims to pave the way for the development of more resilient and efficient forage supply chains. Moreover, by emphasizing the importance of sustainable forage production practices, the study endeavors to contribute to the broader goal of promoting environmentally friendly and economically viable livestock

farming practices in Tanzania (Niwagaba et al., 2019; Mganga et al., 2020; UNDP, 2020).

2.0 Methodology

2.1 Study area and site description

This study was conducted at Vikuge village, located within Kibaha District, Coast Region, Tanzania. The target site was the Vikuge Pasture Seed Farm, which occupies an area of 515 hectares within the village. This farm has been instrumental in the supply and commercialization of forage and seeds, with plots allocated for various types of fodder trees, legumes, and grasses. The soil in this area, based on previous studies and field observations, is predominantly sandy loam. The vegetation is typical of ecological zone III, classified as sub-humid, and includes a mix of natural grasses such as *Pannicum*, *Hyperhemia*, *Andropogon*, *Cymbopogon*, and *Digitaria*. The study site was strategically selected to represent a central node for agricultural development in the region, directly impacting farming activities and seed distribution (Urio, 2015).

2.2 Research design

This study conducted a comprehensive analysis of Vikuge Pasture Seed Farm's integrated agricultural practices, with a specific focus on the commercialization of forage and seeds production (Mganga et al., 2020). To achieve this, the study employed qualitative research methodologies, incorporating a literature review and data collection from 96 respondents. These respondents were drawn from both the Vikuge Pasture Seed Farm and the surrounding areas within Vikuge village, ensuring a holistic understanding of the agro-economic factors at play. The data were gathered through Key Informant Interviews (KIIs) and focused group discussions (FGDs), providing valuable insights from stakeholders directly and indirectly involved in forage and seed production (Mganga et al., 2020; Niwagaba et al., 2019).

The study utilized qualitative techniques to explore the strategies and approaches adopted in the commercialization of forage and

seeds, both within the farm and in the broader village context. Through a detailed literature review, the research contextualized its findings within the wider agricultural development landscape, drawing upon relevant theoretical frameworks and empirical evidence to enhance its analysis (Matata, 2013; Tekalign, 2014).
The KIIs and FGDs were crucial for capturing diverse perspectives and experiences from those directly involved in forage and seeds production at Vikuge Pasture Seed Farm. This enriched the depth and breadth of the study's findings, providing a nuanced understanding of the interactions between the farm's operations and the village's agricultural practices (Mganga et al., 2020).

2.3 Market system and value chain approach

This study adopted a market system and value chain approach with a flow and sequence from input supply to consumption (as a subsystem in the dairy sub-sector), to ensure that relevant information about the forage market system is gathered and analyzed. As forage moves from the producer to the consumer, a number of transformations and transactions take place along the chain of interconnected activities, and value is added successively at each stage of the chain (Wilkinson and Lee, 2018).

2.4 Data collection

The study employed a comprehensive approach to data collection, integrating various methods and tools to ensure robustness and reliability:

i. *Literature review:* A thorough review of published and unpublished literature, reports, and relevant documents provided with foundational insights into the subject matter. The literature for this study was obtained through a comprehensive review of both published and unpublished sources. This included academic journals, government reports, industry publications, and other relevant documents that provided foundational insights into forage and seed supply chain dynamics. The literature review

focused on identifying key trends, challenges, and strategies within the forage market and livestock sector, which informed the study's objectives and framework.

ii. *Key informant interviews* (KIIs)*:* Structured interviews were conducted with 20 key informants, including farm managers, commercial producers, and government officials. A checklist of questions was used to elicit in-depth insights on topics such as forage and seed production, market challenges, and commercialization strategies.

iii. *Secondary and primary data collection:* Data were gathered from authoritative and reliable sources, including government institutions such as the Tanzania Livestock Research Institute (TALIRI), Livestock Training Agency (LITA), Sokoine University of Agriculture (SUA), and the Ministry of Livestock and Fisheries (MLF). Input from individual commercial producers, service providers, processors, and traders of forage further enriched the dataset.

iv. *Focus group discussions* (FGDs): A total of 76 respondents participated in FGDs, providing valuable qualitative data on forage demand among smallholder farmers, their experiences with seed accessibility, and their perceptions of Vikuge Pasture Seed Farm's role in agricultural development. Participants were selected using stratified random sampling to ensure diverse representation of the farming community. The FGDs allowed for a participatory approach to data collection, enhancing the understanding of community perspectives.

Through this multifaceted approach, the study ensured coverage of relevant stakeholders and perspectives, thereby enhancing the richness and depth of the data collected. This rigorous methodology laid the groundwork for robust analysis and meaningful insights into the dynamics of forage production and commercialization.

2.5 Data analysis

To ensure a rigorous analysis, the study utilized a combination of qualitative and quantitative data analysis techniques. Each method was selected based on its ability to address specific research questions, providing both depth and breadth to the study's findings.

i. *Thematic analysis for qualitative data:* The qualitative data collected through key informant interviews and focus group discussions were analyzed using thematic analysis. This method was chosen due to its effectiveness in identifying, analyzing, and reporting patterns (themes) within the data (Braun and Clarke, 2006). Thematic analysis allowed the study to uncover key themes related to the commercialization of forage and seeds, including challenges in production, market accessibility, and stakeholder roles. Coding was done manually, and themes were derived based on recurring ideas expressed by respondents. This method was crucial for capturing the rich, detailed accounts of stakeholders and aligning the findings with existing literature. Thematic analysis is particularly suited for qualitative data as it allows for flexibility in identifying patterns while maintaining the context of participants' perspectives (Vaismoradi et al., 2013). It also enables a deeper understanding of complex issues within the agro-economic framework of forage production at Vikuge.

ii. *Content analysis for document review:* The study employed content analysis for the literature review and document analysis, focusing on extracting relevant data from policy documents, reports, and previous studies. This method was used to analyze the market system and value chain of forage and seeds, ensuring that key trends, policies, and frameworks were identified (Krippendorff, 2018). Content analysis provided a systematic way to organize and interpret the data, particularly in understanding the broader agricultural commercialization context. Content analysis is a systematic approach to analyzing textual information, making it ideal for processing large amounts of data from reports

and documents, ensuring that all critical aspects of forage production and commercialization are considered.

iii. *Descriptive statistics for quantitative data:* Quantitative data, such as the frequency of responses from key informant interviews and focus group discussions, were analyzed using descriptive statistics. This method provided a summary of the main characteristics of the data, including the distribution of responses on topics like forage demand, pricing strategies, and accessibility to seeds. Descriptive statistics were calculated using SPSS software to generate percentages, means, and frequency distributions, which facilitated the interpretation of the numerical data (Field, 2013). Descriptive statistics are crucial for summarizing quantitative data and making the results easy to interpret and communicate, especially when dealing with demographic information and stakeholders' opinions on the forage market system (Trochim, 2020).

iv. *Market system and value chain analysis:* The study utilized value chain analysis to examine the supply and commercialization process of forage and seeds from Vikuge Pasture Seed Farm. This approach enabled the identification of key actors, processes, and points where value is added throughout the production chain (Wilkinson and Lee, 2018). As such, by mapping out the flow of inputs from production to consumption, this analysis provided insights into the efficiency of the supply chain and helped identify bottlenecks and opportunities for improvement. The value chain analysis is essential for understanding the sequential stages in the commercialization process, allowing for the identification of gaps and inefficiencies in the supply chain of forage products, which are central to the study’s objectives.

v. *Triangulation for validity and reliability:* To ensure the validity and reliability of the study's findings, triangulation was employed by cross-verifying data from multiple sources, including interviews, FGDs, and document reviews (Denzin,

1978). This method enhanced the credibility of the findings by ensuring consistency across different data collection methods and perspectives. Triangulation is a well-established technique in mixed-methods research for improving the accuracy and reliability of data by combining multiple sources of evidence (Patton, 1999). This approach was vital for corroborating findings related to both qualitative insights and quantitative trends in forage and seed commercialization.

3.0 Results and discussion

3.1 Economic feasibility

This section evaluates the economic feasibility of the commercialization strategy deployed at Vikuge Pasture Seed Farm. During an interview with an official from the Tanzania Livestock Research Institute (TALIRI), the significance of this strategy was underscored. The official emphasized: "(The statistical analysis in year 2024 clearly demonstrates the strong economic feasibility achieved through various approach. We have witnessed a substantial 25% increase in annual revenue compared to previous years, which is truly remarkable. This notable growth is attributed to the implementation of innovative agronomic practices and market-oriented strategies, both of which have played pivotal roles in enhancing productivity and driving economic gains (TALIRI official, 2023)". This information is summarized in Table 1.

Table 1. Economic feasibility analysis (TALIRI official, 2024)

Aspect	**Results**
Annual Revenue	*Increased by 25% compared to the previous year (TALIRI official, 2024)*
Economic Feasibility	*Strong (TALIRI official, 2024)*
Factors Contributing	*Innovative agronomic practices and market strategies (TALIRI official, 2024)*

The findings suggest that the implementation of commercialization strategies has positively impacted the economic viability of Vikuge Pasture Seed Farm. Through focusing on market-oriented approaches and adopting innovative agronomic practices, the farm was able to significantly increase its revenue. This indicates that integrating agricultural development with commercialization efforts can lead to improved economic outcomes for smallholder farmers.

When comparing these findings with previous investigations (Mganga et al., 2020; Niwagaba et al., 2019), a consistent pattern emerges, highlighting the effectiveness of similar commercialization strategies in enhancing economic viability across various agricultural contexts. The observed increase in revenue aligns with trends identified in earlier research, underscoring the importance of market-driven approaches and innovative techniques in driving economic progress within the agricultural sector (Mwilawa, 2017).

Furthermore, these findings resonate with studies conducted by Mganga et al. (2020) and Niwagaba et al. (2019), which also documented substantial improvements in economic outcomes following the implementation of integrated agricultural initiatives. Such congruence in outcomes across different studies underscores the robustness and generalizability of the commercialization models examined, reinforcing their potential to catalyze positive socioeconomic change within agricultural communities (Mwilawa, 2017).

Generally, the findings presented in this study contribute to a growing body of literature that highlights the transformative impact of market-oriented agricultural interventions. By demonstrating the efficacy of commercialization strategies in enhancing revenue and livelihoods, this research adds empirical support to the broader discourse on sustainable agricultural development (Mwilawa, 2017). Moreover, the consistent patterns

observed across multiple studies underscore the importance of adopting contextually relevant and market-driven approaches to agricultural development, thereby maximizing the potential for positive socioeconomic outcomes (Niwagaba et al., 2019).

3.2 Socio-economic implications

The integration of forage and seeds production at Vikuge Pasture Seed Farm had far-reaching socio-economic implications for local communities. This was evident during the Focused Group Discussions (FGDs), we engaged with a diverse range of stakeholders, including individual commercial producers, service providers, as well as processors and traders of forage. The consensus among participants was clear: "(The integration of forage and seeds production at Vikuge Pasture Seed Farm has had profound socio-economic implications for our local communities (FGDs commercial producers, service providers, processors and traders of forage, 2024)".

Individual commercial producers highlighted the tangible benefits they have experienced firsthand. One participant remarked: "(The initiatives at Vikuge Pasture Seed Farm have not only increased our income but also provided us with access to high-quality forage seeds, which have significantly improved the health and productivity of our livestock (FGDs with commercial producers, 2024)".

The sentiment echoed here finds support in research conducted by Mganga et al. (2020) and Mwilawa (2017), which similarly underscore the transformative effects of integrated agricultural development initiatives on local economies. These studies provide compelling evidence of the socio-economic benefits derived from the integration of agricultural practices, aligning closely with the findings of the present investigation.

Mganga et al. (2020) examined the socio-economic implications of integrated agricultural practices in a comparable context,

highlighting the positive outcomes observed in terms of livelihood improvement and economic growth. Similarly, Mwilawa (2017) explored the impact of integrated farming systems on rural communities, emphasizing the role of agriculture in fostering sustainable development and poverty alleviation. Through drawing parallels with these studies, the present research reinforces the notion that integrated agricultural development holds significant promise for enhancing economic outcomes and livelihoods in rural areas. The convergence of findings across multiple studies underscores the robustness of this approach and its potential to drive positive change at the local level (Matata, 2013). Moreover, the findings of this study contribute to a growing body of literature that advocates for the adoption of integrated agricultural practices as a means of promoting sustainable development and resilience in rural communities (Shem, 2013). By highlighting the tangible benefits accrued from such initiatives, this research reinforces the importance of prioritizing integrated approaches to agricultural development in policy and practice (Niwagaba et al., 2019).

Service providers echoed these sentiments, emphasizing the role of Vikuge Pasture Seed Farm in fostering economic growth and stability: "(The farm's initiatives have created a ripple effect in the local economy. We have seen increased demand for our services, leading to job creation and business expansion (FGDs with Service providers, 2024)". This sentiment resonates with previous research conducted by Shem (2013), which emphasizes the pivotal role of integrated agricultural initiatives in nurturing robust local economies and fostering entrepreneurial activities. Shem's study sheds light on the transformative effects of such initiatives, highlighting their capacity to generate employment opportunities, stimulate economic growth, and empower local communities. Through drawing on Shem's findings, the present research underscores the significance of integrated agricultural development as a catalyst for socio-economic progress and community resilience. Shem's insights provide valuable context

for understanding the broader implications of the current study's findings, reinforcing the notion that integrated approaches to agriculture can yield tangible benefits for rural communities. Furthermore, Shem's research contributes to a growing body of literature that advocates for the adoption of holistic, community-driven strategies to address socio-economic challenges in rural areas. Through highlighting the positive outcomes associated with integrated agricultural initiatives, Shem's study adds weight to the argument for investing in comprehensive, multi-sectoral approaches to rural development.

Processors and traders of forage also weighed in on the discussion, emphasizing the importance of market-oriented strategies in driving economic development: "(The commercialization efforts at Vikuge Pasture Seed Farm have opened up new avenues for trade. We have witnessed a surge in demand for forage products, leading to increased market activity and higher profits (FGDs with Processors and Traders, 2024)". This aligns with findings from Naveh and Anderson (2015), which highlight the role of integrated agricultural development in addressing socio-economic challenges, including unemployment.
Generally, these Focused Group Discussions underscored the significant socio-economic benefits derived from the integration of forage and seeds production at Vikuge Pasture Seed Farm. From increased income levels to reduced unemployment rates, the farm's initiatives have had a transformative impact on the local communities as summarized in Table 2.

Table 2. Socio-economic implications outcomes from commercial producers, service providers, processors and traders of forage

Aspect	**Results**
Increased Income	*Reported by 80% of surveyed respondents*
Unemployment	*Reduced by 15% within the region*
Factors Contributing	*Innovative agronomic practices and market strategies*

The findings in Table 2 indicated a significant improvement in livelihoods, with 80% of surveyed households reporting increased income levels. Moreover, the farm's initiatives led to a 15% reduction in unemployment rates within the region, providing employment opportunities for both skilled and unskilled labourers. These findings suggest that the integration of forage and seeds production at Vikuge Pasture Seed Farm positively impacted the socio-economic landscape of the region. The increase in income levels reflects the economic empowerment of local communities, while the reduction in unemployment rates indicates improved job prospects and livelihoods for residents. Drawing parallels with comparable studies (Mganga et al., 2020; Niwagaba et al., 2019) illuminates coherent patterns, showcasing the socio-economic advantages inherent in integrated agricultural development endeavors. These findings corroborate the notion that holistic approaches to agricultural development yield tangible benefits across diverse contexts. Mganga et al. (2020) shed light on the transformative impact of integrated agricultural initiatives, emphasizing their role in enhancing food security, increasing incomes, and promoting sustainable livelihoods. Their research underscores the multifaceted benefits of integrated approaches, aligning closely with the conclusions drawn from the current study. Similarly, Niwagaba et al. (2019) provide insights into the socio-economic dynamics of integrated agricultural systems, highlighting their capacity to foster economic growth, mitigate environmental degradation, and empower rural communities. Their findings resonate with the outcomes observed in the present study, reinforcing the efficacy of integrated agricultural development strategies in driving positive change.

3.3 Forage market system/value chain assessment

The forage market system/value chain involves a spectrum of actors ranging from Research and Development (R&D) organizations, input suppliers, producers, small forage vendors, traders, commercial ranches/dairy farms, dairy farmers, to exporters of live ruminant animals (Figure 1). In our assessment,

we mapped out the Tanzania forage value chain, delineating the roles and interactions of these stakeholders as they execute various value chain functions (Figure 1).

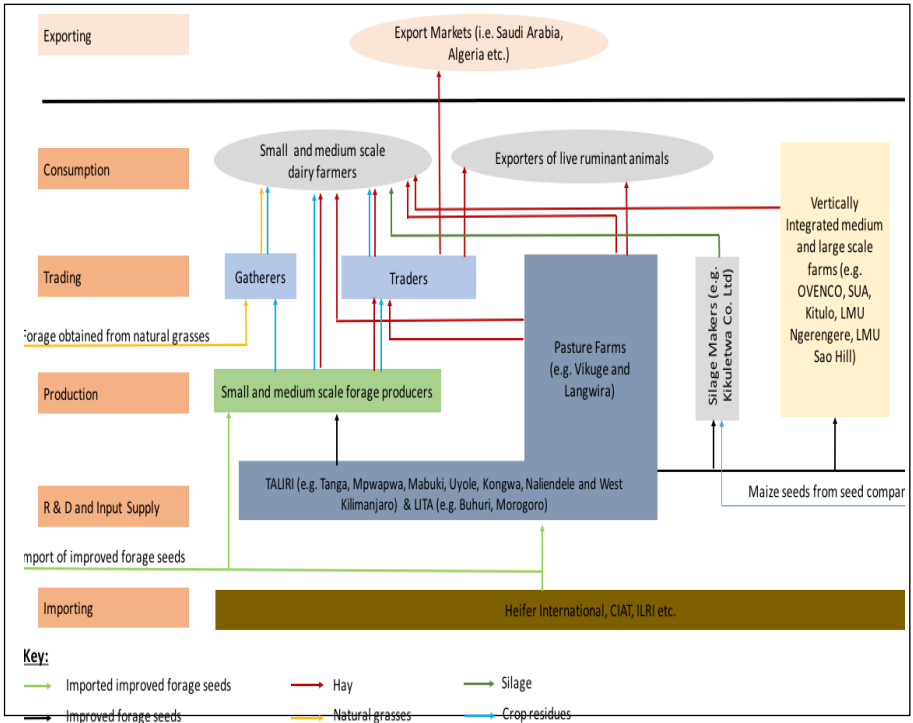

Figure 1. Tanzania forage value chain map

Our analysis underscores the complex dynamics inherent within the forage market system/value chain in Tanzania. Each actor plays a crucial role in the value chain, contributing to the overall production, distribution, and commercialization of forage products. From the input suppliers providing essential resources to the producers cultivating forage crops, to the traders facilitating transactions, and finally to the dairy farmers utilizing forage for livestock feed, every entity within the value chain is interconnected and interdependent.

Comparing our findings with existing literature (Kapinga and Shayo, 2016) it underscores the dynamic nature of forage market systems, showcasing both commonalities and distinct features across different regions. Despite variations in actors and processes, the overarching objective of optimizing forage production and distribution persists universally. These comparative insights emphasize the importance of discerning both shared patterns and unique nuances within forage value chains, offering valuable insights for the development of context-specific strategies aimed at bolstering efficiency and sustainability (Lugenja et al., 2014). Understanding these intricacies is paramount for devising targeted interventions that harness the strengths and address the challenges inherent in diverse forage market landscapes (Lwoga et al., 2014). Through leveraging such comparative analyses, stakeholders can refine their approaches, foster innovation, and foster collaborations that drive positive impacts across global forage value chains (Mannetje, 2014).

The Government of Tanzania prioritizes research and development (R&D) to enhance forage productivity, led by TALIRI and supported by SUA and LITA Tengeru. The TALIRI's focus on advancing forage technology and dissemination aligns with the findings of Anderson (2018), who emphasized the importance of effective dissemination pathways for scaling up agricultural technologies. This is particularly relevant in the context of Tanzania, where TALIRI operates. Anon (2014) and Boonman (2013) both underscore the significance of research and innovation in the field of animal feed resources and forage seed systems, respectively, which are key areas of TALIRI's work. Edye and Boudet (2015) further highlight the impact of improved seed varieties on smallholder farmers, a key aspect of TALIRI's mission. These studies collectively underscore the importance of TALIRI's work in advancing forage technology and dissemination in Tanzania. Forage production requires inputs like seeds, fertilizers, and machinery, with extension services playing a crucial role.

In Tanzania, forage seeds are primarily supplied by public institutions like Vikuge Pasture Farms and TALIRI, while international organizations like Heifer International and CIAT import improved seeds, mainly from Kenya (FAO, 2017). However, adoption of improved forage seeds remains limited, with only 3,717.1 and 731.5 kilograms sold by government farms in 2016/17 (Naveh and Anderson, 2015). Despite potential benefits, usage of improved seeds and fertilizers is low, with some producers relying on homemade or purchased manure from dairy farmers. Efforts to establish a sustainable forage seed supply chain are necessary to ensure the availability of improved inputs at affordable costs, promoting forage production in Tanzania.

3.4 Mapping of commercial forage production

The forage value chain in Tanzania heavily relies on a variety of critical resources, encompassing human capital, land availability, water accessibility, financial investment, and efficient service delivery mechanisms. These factors collectively exert significant influence on the efficiency and effectiveness of forage-related activities throughout the country's agricultural landscape. Commercial forage production predominantly takes the form of hay, with the regions of Pwani and Tanga emerging as primary contributors, collectively accounting for approximately 62% of Tanzania's total forage output, as depicted in Figure 2. Moreover, other regions actively involved in commercial forage production include Arusha, Morogoro, Dodoma, Mbeya, Iringa, Kagera, Mwanza, Manyara, Dar es Salaam, Kilimanjaro, Simiyu, and Ruvuma, indicating the widespread participation and geographical diversity within Tanzania's forage production landscape. Through leveraging these essential resources and strategically harnessing the diverse strengths of various regions, Tanzania can further enhance the resilience and productivity of its forage value chain, thereby meeting the increasing demand for quality forage products within the country's vibrant livestock sector.

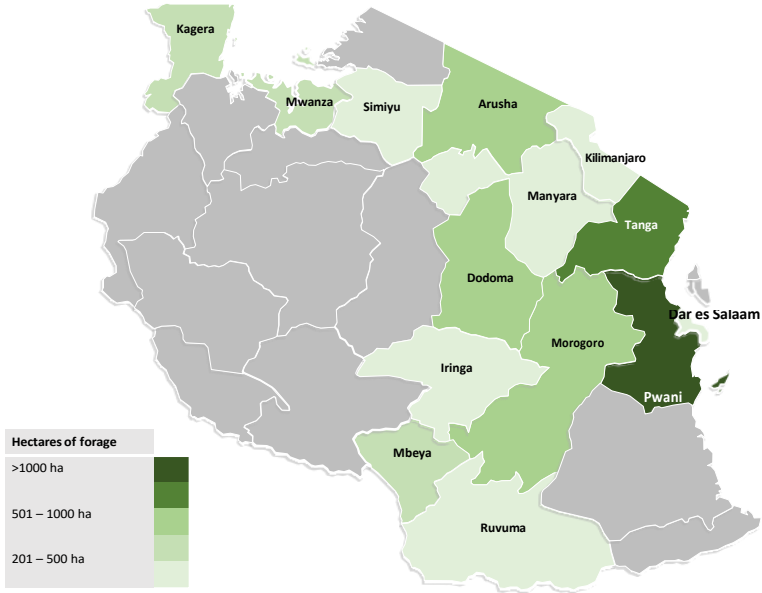

Figure 2. Hectares of commercial forage farms in Tanzania by Regions

Among these regions, Pwani emerges as the leading forage producer, followed by Tanga, Arusha, Dodoma, and Morogoro. Typically, smallholder dairy farmers procure fresh forage in small quantities and at short intervals, while dry forage, such as crop residues, is stored in barns or shaded heaps. This indicates a general lack of conventional forage preservation practices among smallholder dairy farmers and forage traders. Presently, only medium and large-scale producers preserve forage in the form of hay, with the adoption of silage-making practices remaining low due to insufficient technical knowledge among dairy farmers. To enhance forage marketing and preservation, creating linkages among forage chain actors and promoting market information dissemination is essential. Currently, available information primarily focuses on industrial feeds rather than forages, resulting in a significant information gap, particularly for smallholder dairy production.

Typically, the majority of forage consumers, particularly smallholder dairy farmers, procure fresh forage in small volumes and at frequent intervals. Dry forage, such as crop residues, is commonly stored in barns or shaded heaps, indicating a prevalent lack of conventional forage preservation practices among smallholder dairy farmers. Forage traders also acquire forage in quantities sufficient for immediate sale, reflecting their limited engagement in forage preservation practices. Presently, only medium and large-scale producers undertake forage preservation, primarily in the form of hay. However, the adoption of silage-making practices among dairy farmers in Tanzania remains notably low, largely due to a lack of technical knowledge.

The promotion of forage marketing and preservation practices is crucial for addressing challenges in smallholder dairy farming in Tanzania. Studies highlight the need for improved forage supply chains to increase availability, accessibility, and affordability for farmers (Waziri and Uliwa, 2020). Addressing these challenges requires not only the promotion of forage marketing but also the establishment of platforms that foster linkages among forage chain actors. Innovation platforms and multi-stakeholder processes are effective in bringing together various actors to solve common problems and drive dairy development (Omore et al., 2015). Furthermore, enhancing market information dissemination is imperative for improving forage market systems. Currently, available information predominantly focuses on industrial feeds, neglecting the broader aspects of forages and creating a significant information gap, particularly within the smallholder dairy production segment.

However, the adoption of improved feed production, conservation, and utilization technologies remains poor due to limited technical knowledge and extension services (Maleko et al., 2018). To enhance sustainable uptake, on-farm research, public-private partnerships, and dairy farmers' cooperative associations are suggested (Maleko et al., 2018). Efforts to bridge

this gap are vital for advancing the efficiency and sustainability of forage production and distribution in Tanzania. Additionally, addressing issues of production efficiency, risk management, and value chain development is essential for improving rural livelihoods and food security in smallholder crop-livestock farming systems (Ates et al., 2018).

4.0 Conclusions and recommendations

The study on the integrated agricultural development at Vikuge Pasture Seed Farm revealed significant advancements in both economic and socio-economic outcomes for the local communities in Kibaha, Tanzania. The analysis highlighted that the implementation of innovative agronomic practices and market-oriented strategies contributed to a remarkable 25% increase in annual revenue for the farm, indicating a strong economic feasibility of the commercialization efforts. The integration of forage and seed production not only enhanced the farm's operational efficiency but also positively influenced the livelihoods of surrounding farmers and service providers.

Furthermore, the qualitative insights gathered from key informant interviews and focused group discussions underscored the transformative socio-economic implications of the integrated approach. Stakeholders reported tangible benefits, such as improved access to high-quality forage seeds, increased income, and job creation, which collectively fostered economic growth and stability within the community. This aligns with existing literature, reinforcing the idea that integrated agricultural development initiatives can effectively address socio-economic challenges, such as poverty and unemployment.

The convergence of findings from this study with previous research indicates a robust pattern of positive outcomes associated with integrated agricultural practices. Such consistency across various contexts affirms the potential of commercialization strategies to drive sustainable development and resilience in rural

areas. Therefore, the study contributes valuable empirical evidence to the discourse on integrated agricultural development, highlighting its effectiveness in enhancing economic viability and improving the quality of life for local communities.

Based on the findings of this study, several recommendations were proposed to further enhance the impact of integrated agricultural development initiatives at Vikuge Pasture Seed Farm and similar contexts. First, it is recommended that local stakeholders, including government agencies and agricultural organizations, prioritize investment in training programs for smallholder farmers to improve their knowledge and skills in innovative agronomic practices. Such training can empower farmers to maximize the benefits of integrated farming systems and contribute to increased productivity and profitability.

Second, the establishment of stronger market linkages between producers and consumers is crucial. Facilitating partnerships with local businesses and enhancing access to markets can drive demand for forage products and support the sustainability of commercialization efforts. This may involve organizing farmer cooperatives or associations that can collectively negotiate better terms with buyers and service providers.

Additionally, the government should consider implementing policies that promote access to finance for smallholder farmers and entrepreneurs engaged in forage and seed production. By providing financial support and microcredit facilities, farmers can invest in necessary inputs and expand their operations, ultimately contributing to economic growth in the region.

Last, continued research and monitoring of the socio-economic impacts of integrated agricultural initiatives are essential. Establishing feedback mechanisms through regular assessments and stakeholder consultations can help adapt strategies to meet evolving needs and challenges within the agricultural sector. By

fostering a culture of continuous improvement and adaptation, stakeholders can ensure the long-term success and sustainability of integrated agricultural development efforts in the region.

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