ACHIEVING LOW EMISSION DEVELOPMENT

Anticipating Alignment between Global Strategies and Local Realities in the Tanzanian Dairy Sector

Esther Mwihaki Kihoro

Propositions

1. An exclusive emphasis on individual choices hinders the understanding of inclusive development (this thesis).
2. Inclusive business involves continuous improvisation in responding to everyday challenges (this thesis).
3. The check-box syndrome in research and development contributes to failure in achieving sustainability.
4. Combining multiple research methods is paramount for understanding local realities.
5. Happiness in life is not a function of privilege.
6. Climate change policies gives too much credence to technology and ignores social innovations.

Propositions belonging to the thesis, entitled

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Thesis

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The single story creates stereotypes,
and the problem with stereotypes is not that they are untrue,
but that they are incomplete.
They make one story become the only story.

Chimamanda Ngozi Adichie

Table of Contents

List of Tables

List of Figures

To my family

Chapter 1

General introduction

1 General introduction

1.1 The societal challenge: dairy production versus emissions in Africa

Over the past two decades, the global agenda for greenhouse gas (GHG) emission reduction in agriculture has become ever more prominent. The global climate change agenda dictates an urgent need to make food production systems more resilient, socially inclusive and environmentally sustainable (Buseth, 2017). The renewed focus on climate change has led to increased pressure from global discourses on national governments to commit to sustainable development and achieve both economic growth and emission reductions. As such, national governments in developing countries are committing to low-emission development goals. Low Emission Development (LED) strategies seek to reduce greenhouse gas emissions, increase productivity and support economic development in a "coherent and strategic way" (OECD-IEA, 2010, p. 6). From a global perspective, the 2016 Paris Agreement seeks to address some of these aspects by providing funding and technical assistance to developing countries seeking to support the design and implementation of emission reduction policies. The Paris Agreement Article 4.2 states that member countries must prepare and communicate their nationally determined contributions (NDC) (UNFCC, 2015). The NDC is intended as a legal framework for each country that outlines its mitigation and adaptation strategies, among other aspects (e.g., financing).

The livestock sector is one of the promising avenues for reducing GHG emission intensities and contributing to household economic gains. Livestock accounts for 65% of global agricultural GHG emissions (Thornton and Herrero, 2010; Tubiello et al., 2014). In Tanzania, the livestock sector accounts for 72.5% of total emissions from agriculture (Irish, 2018, p. 12), while dairy contributes 16% of the national GHG emissions. Within East Africa, livestock, especially dairy production systems, play an essential role in terms of food security, income and Gross Domestic Product (GDP) (Herrero et al., 2016; Makoni et al., 2014). The Eastern African region produces most of the milk at 68% of overall milk production in Africa (Makoni et al., 2014). The milk is mainly produced in Kenya, Uganda, Ethiopia, and Tanzania. In Tanzania, dairy is the largest agriculture subsector employing 1.7 million households (FAO, 2019). The success in the dairy sector is driven by population growth, urbanization, and improved purchasing power. Based on the current population growth, it is projected that Tanzania will have a milk deficit of 5.8 million litres in 15 years (FAO, 2019). However, current productivity within the dairy sector is low (1.8%), highly

constrained by disease prevalence, seasonal variability in feed access and high mortality rates (FAO, 2019; Makoni et al., 2014).

This highlights the complex relationship between the economic benefit of dairy, its contribution to GHG gas emission and the vulnerability of dairy systems to climate change. Reducing emission intensities involves increasing productivity which reduces GHG emissions per unit of output (Havlík et al., 2014; Herrero et al., 2016). Nonetheless, dairy production systems are inherently sensitive to climate change, mainly regarding feed availability and input prices.

1.2 Problem statement

For the livestock sector, so-called "triple-win LED outcomes" can be achieved through productivity gains, improving profitability, and reducing GHG emissions intensities. National climate change policies and strategies provide generic guidance on technical interventions, whereas livestock mitigation is mainly framed as intensification through technology adoption. This is because practices that increase livestock productivity have the potential to reduce emission intensity as a co-benefit (Herrero et al., 2016). In dairy, these include; (i) improved feed quality and quantity; (ii) improved animal husbandry and health; and (iii) improved manure management through proper storage and reuse (Herrero et al., 2016). However, LED often remains an overarching goal that lacks clear implementation strategies and does not always correspond with local interests, priorities and institutional arrangements (Garnett et al., 2013). Mitigation goals are rarely a priority for local producers; instead, smallholders' livestock-keeping practices are driven by various objectives, including profit, nutrition and other economic and social-cultural considerations (Weiler et al., 2014). Therefore, technocentric LED strategies fail to account for the socio-institutional dimensions of production and distribution that shape the uptake of proposed technologies (Herrero et al., 2016; Taylor, 2018) and the understanding of farmer heterogeneity in terms of their capabilities and needs.

In addition, the place of dairy intensification in the overall farm economy is not well understood. For instance, does intensification result in farm and income diversification, and what are the drivers of this relationship? While previous research suggests that productivity leads to lower emission intensities (Havlík et al., 2014; Thornton and Herrero, 2010), the relationship between LED and socio-economic gains is less obvious. Dairy intensification may require households to divert productive assets, including land, capital and labour allocated to other livelihood activities,

which may hurt overall household welfare. This is especially important in East Africa, where dairy farmers operate within diversified mixed crop-livestock production systems. Such systems comprise a complex mix of on and off-farm activities (Acosta et al., 2021; Barrett et al., 2001). Previous research has investigated either diversification or intensification strategies and effects on socio-economic outcome indicators, such as food security on agricultural intensification. Still, there is limited knowledge on the relationship between dairy intensification and diversity in terms of dietary and livelihood options.

Additionally, there is a disconnect between national and local government authority's priorities regarding implementing and financing national-level policy directions and strategies (Nachmany, 2018). Other challenges include a lack of implementation procedures contextualised to varying local dynamics. Additionally, the adoption of such practices is shaped by broader power relations beyond households, at government, and at market levels, shaping agricultural development (Clapp et al., 2010). Such a narrow, top-down, technocentric conceptualisation of LED has implications for what solutions are promoted and which actors or areas benefit (Newell and Taylor, 2018). This results in a mismatch between global and national environmental policy and rural development priorities, which raises several gaps that need to be filled to align the two priorities. Therefore this thesis aims to contribute to whether and how global LED strategies can align with local realities.

In the following sections, I further elaborate on the aspects assessed in this thesis. Section 1.3 discusses approaches toward LED, which include i) technocentric approaches and adoption, ii) unpacking heterogeneity and technical changes and iii) contextualising socio-technical change within the dairy sectors in Tanzania. Section 1.4 elaborates on the objectives and provides the research questions addressed by the study. Section 1.5 provides the research design and methods, and finally, Section 1.6 provides the outline and structure of the thesis.

1.3 Approaches toward LED

The last decade has seen multiple development initiatives within Africa which target livestock keepers and encourage them to increase their productivity. However, such initiatives are rarely tailored to livestock keepers' wants and needs. Instead, the initiatives are framed as technological best practices that contribute to GHG emission reductions if adopted. For the dairy systems, improved LED practices include; (i) improved feed quality and quantity, such as fodder production and feeding concentrates for providing high-quality and high-protein feed to cows (Thornton and

Herrero, 2010). Previous works demonstrated that improved feeding practices could reduce emission intensities by 8–35% (FAO, 2019) (ii) improved animal health and farming practices, including a suite of practices. These include timely deworming artificial insemination, tick control and observing required calving intervals. (iii) Proper manure storage and management can reduce emissions from manure by up to 90% by reducing anaerobic decomposition (Ericksen and Crane, 2018). Appropriate use of manure on soil can contribute to more efficient nutrient use, soil quality and crop productivity while replacing synthetic fertilisers and their associated emissions (Chadwick et al., 2011).

The productivist mindset – where increasing efficiency to enhance milk production is the primary objective – continues to inform dairy system policy in Tanzania. Various national-level strategies and policies collectively aim to facilitate the intensification and commercialisation of the livestock and dairy sectors, primarily through technology upgrading and mobilising private sector investment, as outlined in the Tanzania Livestock Master Plan (2017). The adoption of improved technologies also sets the premise for emission reduction. Additionally, most development projects in Tanzania also focus on technocentric approaches to increase milk production, such as the East African Dairy Genetics Gain (ADGG), which focuses on breed improvement, and the East Africa Dairy Development (EADD) Project. While a focus on improving productivity and commercialisation is beneficial, there is also a need to understand contextual aspects that enable or constrain uptake.

In Tanzania, the link between livestock and climate change is outlined in various policy documents. These include the Tanzania National Climate Change Strategy (NCCS) of 2012 (URT, 2012) and the Tanzanian Climate Smart Agriculture Guidelines (2017–2025). The NCCS summarises mitigation strategies within the livestock sector, including strategies for manure management, improved feed production, improving rangelands productivity and waste management in abattoirs (URT, 2012, p. 65). However, the Tanzania NDC mainly prioritises agriculture from an adaptation perspective due to the potential adverse effects of climate change (URT, 2021).

1.3.1 Technocentric approach and adoption

Adoption studies remain at the core of technological change. Adoption studies mainly focus on the rate and effects of adopting technology (Glover et al., 2016). However, in recent years, the

limitations of adoption studies have been highlighted (Glover et al., 2019, 2016; Temple et al., 2016). The first adoption challenge is depicting technologies as discrete and generic packages, easily transferable across settings (Doss, 2006; Glover et al., 2016). The second challenge is the preconception of technological change as a simple individual choice about whether to adopt a new technology or not. Where the old practices are referred to as inferior and make way for new approaches, as noted by Glover (2016), "… inferior existing materials, tools and/or methods become obsolete and are abandoned in favour of new, superior ones" (Glover et al., 2016, p. 4).

Adoption concepts become insufficient when applied to complex technological change concepts. For example, sustainable agriculture involves various components integrating multiple social and technological concepts, including adopting new technologies, engaging in markets, and navigating household dynamics and politics within the market sphere. When applied to such systems, there is a risk of overlooking the consequences of adoption. Other aspects that risk being overlooked are distributional aspects. Scholars who want to overcome these challenges conceive technology as a more fluid mix of technical and social elements, where socio-technical change is more complex, iterative, situated, and contingent (Glover et al., 2016; Jansen and Vellema, 2011). Therefore, opportunities to take up new practices are driven not only by the intrinsic value of the technologies and the measurable attributes of the technical package, but also by the dynamic interaction between the technology attributes, potential users, and their environmental and institutional context. Therefore, the ability to adopt different technologies is context-specific based on individuals' characteristics (e.g., knowledge, aspirations, intelligence), their resources (e.g., land, labour, money), agroecological conditions and their social-cultural norms and rules (Glover et al., 2019). This creates a need to engage in a deeper understanding of technological change to understand the processes and consequences of change driven by technical components and socio-institutional across scale.

1.3.2 Connecting heterogeneity and technical change

Approaching LED from a techno-centric approach can give a false impression of heterogeneity between producers and various actors in dairy production systems. Focusing on technocentric approaches fails to account for the following aspects. Firstly, most technocentric LED interventions are based on a one-size-fits-all approach to extension support. This fails to account for farmer heterogeneity and how it shapes the uptake of new practices – which includes

differences in farmers' capabilities in terms of financial capital, skill in dairy products and access to other production assets (e.g., land and labour). For instance, some farmers might want to intensify because they have less land, which is not conducive to grazing. In other cases, farmers with larger farms may want to practice paddocking or semi-intensive dairy and focus on other cash crops (e.g., tea). Other differentiating factors include family size, labour shortages and capital constraints. By ignoring these factors, such approaches fail to acknowledge that "transitions to intensive dairy production systems can have uneven impacts in rural areas, leading to the marginalization of some households" (Clay and Zimmerer, 2020, p. 39).

Secondly, technocentric LED interventions tend to be designed around the assumption that intensification and productivity gains produce socio-economic benefits for all producers. This assumption ignores that the costs and benefits from intensification do not necessarily meet the financial and social interests of every producer equally (Tavenner et al., 2019). The Dorward framework proposes three distinct household strategies: "hanging in," "stepping up", and "stepping out," which can be used to explain households' trajectories (Dorward et al., 2009). Producers "hanging in" are usually resources constrained, and their goal is to maintain their current livelihood level. Producers "stepping up" are advancing and investing resources in agricultural activities to increase productivity. Finally, producers "stepping out" are diversifying into non-farm activities and sometimes transition out of agriculture (Dorward et al., 2009). For instance, some farmers might be hesitant to adopt the "hanging in" strategy, to avoid increased risks in case cows die and sacrifice land and resources for food production. Understanding such varying trajectories is beneficial in designing LED strategies that account for heterogeneity and move away from the "one-size-fits-all" approach.

Finally, intensification is subject to the natural environment. For instance, semi-arid areas have a lower comparative advantage than highlands where temperatures are lower, rainfall is sufficient, and disease incidence is lower. Therefore, such regions need different practices to enhance productivity. The technocentric approach is geared toward increasing milk productivity at the expense of understanding how various components in the systems (e.g., local power dynamics, agroecology, and culture) interact to shape dairy systems. This raises the need to understand how environmental and political-economic contexts shape the adoption of LED practices within dairy

systems (Clay and Zimmerer, 2020). Necesitaing thinking about change as incremental, area-specific and contextual, rather than using a blanket, technocentric approach to LED.

1.3.3 Contextualising socio-technical change in Tanzania

Dairy development has undergone various transformations across the last seven decades in Tanzania. Before independence, dairy production and milk processing were private-sector functions. After implementing the socialist Ujamaa system in 1967, the government became a major producer and processor of milk (Kurwijila, 2001). This was achieved through the Development of Livestock Development Authority (LIDA) with two subsidiary companies, a dairy farming company (DAFCO) and Tanzania Dairies Limited (TDL) (Nell et al., 2014). DAFCO oversaw several large-scale parastatal dairy farms. However, the government changed its socialist policies and adopted economic liberalisation policies in 1985, when it started to divest its direct involvement in the dairy sector. Milk prices were deregulated in 1988, and by the mid-1990s, the privatisation of all milk-processing plants and some dairy farms started (Kurwijila, 2001). In 2004, the government enacted the Tanzania dairy industry bill, which made provisions for the establishment of the Tanzania Dairy Board (URT, 2004). The mandate of the board was to regulate, coordinate and catalyse growth in the dairy sector.

Although the state is quite present in other sectors in Tanzania, its current role in the dairy sector is limited. Agricultural and livestock functions were devolved from the national government to local governments (1998–2002). Regional governments have autonomy in prioritising their investments within the dairy sector. The local government authorities (LGA) are autonomous of sectoral ministries and report to regional governments. Livestock officials report to the local government at the district, regional, and national levels, then to the ministry of livestock and fisheries development. Sectoral agencies have no direct oversight in the districts. Therefore, local politics and alliances shape what sectoral agencies do. Although the decentralised governments have autonomy, most of the agriculture and dairy sector policies come from the national government. Additionally, LGAs rely both on internal revenue collection and national-level budgetary allocation. The revenue collections are aggregated and allocated across departments on a needs basis; although most revenue collections are from agriculture or livestock, the allocation of funding is not proportional to the revenue collection.

Previous studies show that the modalities of business engagement are continuously negotiated, and the outcomes are conditioned by how they are embedded within territorially specific social norms and politics (Helmsing and Vellema, 2011a; Muilerman and Vellema, 2016). This underscores the need for capturing diversity by analysing the needs and realities of local development agendas, which potentially shape distinctive business systems (Waller et al., 2020). A business system in this study is defined as a unit of distinctive spatially bound economic organisation defined by societal context and institutions resulting in distinct "market rules and actors, such that they manifest contrasting patterns of economic organisation and generate different outcomes" (Whitley, 2003, p. 3). In approaching LED from this perspective, I acknowledge that the implementation of the global-national policies on LED is contingent on how the private sector reacts to the guidelines, as well as the interactions between the public and private sector actors in implementing the policies and strategies.

1.4 Research objectives and questions

Because of the technocentric approach to LED, there is a risk of focusing on adopting LED practices at the farm level and paying little attention to other aspects beyond the farm, which shape the business and market environments that shape LED uptake. Based on the concepts discussed above, the primary objective of this study

> **Is to assess the local-level dynamics within households, business systems and markets in order to anticipate whether and how global-level policies on LED can align with local realities in the Tanzanian dairy sector**.

The secondary objective of the thesis is to contribute to the methodological approaches that demonstrate that context matters and to provide a practical example of how to operationalise analysis of heterogeneity across multiple levels of study, namely at the levels of farms, business systems and markets.

Achieving these objectives necessitates answering this overall research question:

> **What conditions enable alignment between LED strategies and local dairy development practices that ensure emission reduction and social benefits across diverse and heterogeneous systems?**

At the farm level, I interrogate farmer heterogeneity in terms of assets, capabilities and needs concerning dairy production and their ability to adopt LED practices. At the business systems level, I evaluate the aspects that enable LED. This includes an analysis of private sector interactions with the state, the nature of competition among traders and the historical path dependence in dairy that either enables or constrains LED strategies across spatially distinct geographic areas. At the market level, I shift focus to how traders' practices can be responsive to local producers' cultural and production needs instead of only relying on top-down prescriptive marketing structures. This approach allows us to undertake a holistic analysis of the socio-economic and institutional aspects that shape the alignment of LED strategies across multiple levels. In doing so, this thesis seeks to answer the following specific research questions.

Specific research questions

1. How do we use multilevel analysis to detect alignment between LED and local dairy production needs (entire thesis)?
2. What are the differentiated pathways for scaling LED strategies that better account for divergent smallholder capabilities, strategies and interests (Chapter 2), and what are the household outcomes of dairy intensification (Chapter 3)?
3. How do spatially distinct business systems influence the conditions for inclusive low-emission dairy development (Chapter 4)? What enables business practices to be tailored toward the realities of marginalised producers in achieving LED (Chapter 5)?

1.5 Research design

In this study, I employ the following design. I start with introducing the discourse and frameworks used to unpack diversity and different transformation pathways for LED anchored in the pathways to sustainability approach. I use a multilevel approach, which explores various angles of economic, social, and institutional aspects that are instrumental in shaping LED. After that, I outline the methods used in data collection and the study sites.

1.5.1 Pathways approach

Like other previous agriculture imaginaries (e.g., the Green Revolution), LED strategies mainly focus on getting the science and technologies right without paying much attention to the messy aspects of institutions and socio-economic aspects that shape technology change. The

technocentric approach focusing on the "one-size-fits-all" fails to bring along sustainable change. Various conceptual approaches have been previously employed to analyse societal transformation processes (see. Patterson et al., 2017). While there are varying definitions of transformation, most concepts of transformation refer to system models – conceptualized as complex, dynamic, and multi-level entities (Feola, 2015; Patterson et al., 2017). Consequently, transformation is defined as a process involving the interaction of units at different levels and across time (Feola, 2015). Transformation is herewith defined as "changes in structural, functional, and relational aspects of socio-technical-ecological systems that lead to new outcomes" (Patterson et al., 2017, p. 2). This definition helps bridge the multiple processes and domains needed to effect change.

This study employs the pathways to sustainability approach (Leach et al., 2010a), which focuses on transformation in human development. This approach explicitly regards transformation as a transitional process continuously shaped by the social response (Leach et al., 2010a), as well as varying spatial and structural contexts (Lindahl et al., 2016). It emphasises that transformation is political, continuously changing, and complex (Leach et al., 2010a; Patterson et al., 2017). The pathways approach acknowledges the presence of dominant pathways often driven by powerful actors (e.g., governments) and alternative pathways that may not follow the dominant trajectory. In Tanzania, LED strategies for dairy are unfolding via intensification and commercialisation as the dominant pathway, encouraged through national-level policies. However, the pathways approach also acknowledges alternatives that provide more pluralistic approaches that involve both social and technological innovations where there is less government involvement (Fraval et al., 2019; Scoones et al., 2018) and more outstanding agency from other actors (Ely, 2021). Agency is essential in defining the direction of transformation, shaped by various relationships, values and knowledge (Ely, 2021; Scoones et al., 2018). This means that, for sustainable change to occur, there is a need to engage with change as a complex process (Mehta et al., 2021).

1.5.2 Understanding diversity using a multilevel approach

Agriculture occurs in diverse systems: varying farm sizes, socio-economic profiles, agricultural practices, socio-cultural environments, historical backgrounds, and biophysical and political environments (Sumberg and Giller, 2022). A multilevel perspective is used to unpack diversity at the farm, business systems and market levels, and potential LED pathways under each unique situation. For each of these levels of analysis, a specific framework to analyse diversity is

employed. As Sumberg and Giller, (2022) note, homogenising agriculture risks jeopardising efforts to achieve sustainable agriculture and food security (Sumberg and Giller, 2022).

Firstly, I used Dorwards' framework to understand farmers' heterogeneity and agricultural transformation trajectories (Dorward et al., 2009). The framework is based on the simple supposition that households aspire to retain and advance their current well-being. Dorward proposes three main household strategies "hanging in", "stepping up", and "stepping out". These strategies can help explain producers' adoption behaviours and trajectories for LED.

Secondly, I use the Business Systems Framework to understand variability at the business systems level. Climate change is intrinsically political in the context of; uneven commercialisation, varying forms of capital accumulation, dynamic state regulations and emerging rural subjectivities (Taylor, 2015). These social-institutional relations coalesce to form distinctive business systems in which households produce and engage economically. By bringing such aspects into this analysis, it helps us understand how LED will potentially interact with these dynamics and the resultant socio-equity dynamics. Here, I use the Business Systems Theory (BST) (Whitley, 1999) to assess spatial differences in business systems. I use BST to distinguish unique aspects of local business environments by understanding the role of government, the interaction between firms and how this leads to societally distinct modes of coordinating economic action (Whitley, 1999).

Third, I zoom in on a specific location to understand traders' practices that enhance the inclusion of pastoralists in milk markets. Using the practice approach, I interrogate the actual practice of business, which shapes the alignment of marginalised producers and traders' goals (Chapter 5). Here, I draw on the scholarly work by (Nicolini, 2012), who argues that "practices are meaning-making, identify-forming, and order-producing activities. They institutionalise activities and ways of doing through repetition" (Nicolini, 2012, p. 7). This provides an analytical approach to demonstrate that actors' economic and social outcomes in a society are shaped by their everyday activities and actions, which shapes agency.

1.5.3 Description of study sites.

The main focus of this study is Tanzania; however, a comparative analysis between different areas in Tanzania and Kenya was done in chapter 3 to improve on the external validity of the study findings. In Tanzania, the study targeted four major milk-producing districts, while additional data

from three counties in Kenya were used for the comparative analysis (Figure 1.1. Map of study sites in Kenya and Tanzania).

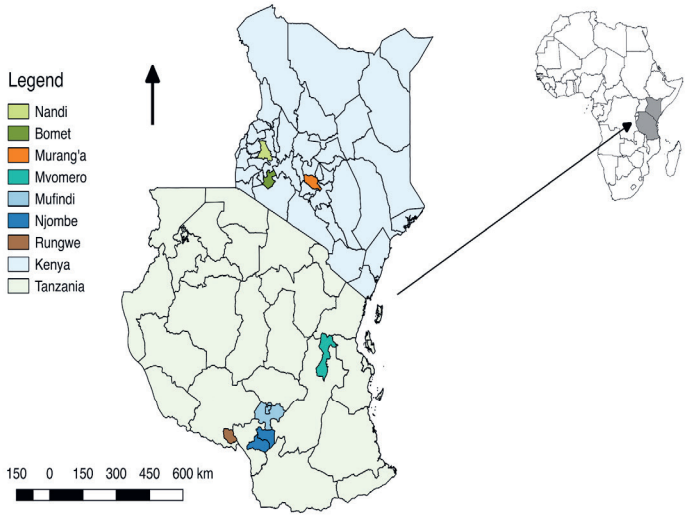

Figure 1.1. Map of study sites in Kenya and Tanzania

The Tanzania study sites included Mvomero district in the Morogoro region, Mufindi district in the Iringa region, Njombe district in the Njombe region and Rungwe district in the Mbeya region. In Kenya, the study sites were Nandi, Bomet and Murang'a counties. The case study (Chapter 5) was conducted in the Dakawa ward within the Mvomero district in the Morogoro region of Tanzania. Dakawa was selected due to the innovativeness expressed by traders in ensuring milk from pastoralists was marketed. The study sites were chosen for their production potential, ecological differences. and relevance to national dairy development priorities. Additionally, site selection decisions sought to capture economic differences to enhance external validity.

1.5.4 Methods for data collection and analysis

Assessing diversity across households and business systems necessitated a mixed-methods approach. A quantitative approach to social science was used to understand farmers' heterogeneity and LED uptake. Here an econometric analysis was used to unpack household heterogeneity and the welfare outcomes associated with LED uptake. This was implemented using semi-structured household surveys (Chapters 2 and 3). The formal surveys were used to understand household differences and patterns in LED uptake across household types (Chapter 2). A qualitative approach was used to understand differences within business systems and business practices and how they

are likely to influence LED uptake. Here key informant interviews were employed in chapter 4, while a detailed case study approach was used in chapter 5. *Table* 1.1 below presents a summary of the data collection methods used for each chapter.

Table 1.1. Methods for data collection

Chapter	Topic	Formal surveys	Key Informant Interviews	Case study	Participatory workshops
2	Farm level heterogeneity	X	X		X
3	Welfare outcomes for LED	X	X		
4	Heterogeneity at the Business Systems Level		X		X
5	In-depth case study on inclusive business practice	X		X	

Chapter 3 employs a comparative analysis to demonstrate the link between dairy intensification and farm diversity and its implication on livelihoods across various research sites in Kenya and Tanzania. Data was collected using an improved version of the Rural Household Multi-Indicator Survey (RHoMIS) questionnaire (Hammond et al., 2017). It covered several aspects; household demographics, incomes, dairy practices, dairy marketing, dietary diversity, and wealth portfolio of the households. Random sampling accounted for economic, geographic and agroecological differences across the two countries. A detailed explanation of the sampling strategy is discussed in Chapter 2. Surveys follow questions based on the researcher's perspective and may not capture all the respondents' perceptions. I used other qualitative data collection methods to identify aspects to further elaborate themes emerging from the household surveys. These included key informant interviews and feedback workshops to interpret the farmer typologies and analyse the barriers and opportunities for LED uptake across farmer types.

Chapter 4 draws on qualitative data designed to unpack the contextual factors that shape dairy business systems across four districts in Tanzania. Data was collected using key informant interviews, actor mapping and document reviews. Actor mapping was used to understand the links between actors' by assessing their levels of integration and/or competition. Key informants are defined as a select group of individuals who provide key ideas and information about a particular topic (Kumar, 1989). The key informants interviewed included government representatives within

the livestock department in each local government authority (LGA), representatives from development organisations implementing dairy-related projects within each study district, and representatives from milk processors, traders, and farmer organisations. The interviews were conducted following an interview guide covering selected topics. However, I also encouraged the respondents to explore new topics that brought new insights that further enriched the study. Key informant interviews were also used to triangulate data collected across all the other chapters.

Chapter 5 uses a case study approach to evaluate business practice shaping endogenous marketing dynamics in Dakawa Ward, Mvomero district. A case study allows an in-depth analysis of a phenomenon (Gerring, 2004) within its real-life setting. As such, the case study was useful in helping understand individual traders' business practices and their agency in shaping economic action. Using a case study allowed a context-specific analysis of practices that shape alignment and the complex interactions between actors that demonstrate how economic activity evolves. The selection of respondents depended on their engagement in milk marketing. All traders selling milk in Dakawa were interviewed, and motorbike milk aggregators who delivered milk to the traders were also interviewed. Questions were unstructured, guided by my line of inquiry. However, I allowed traders and motorbike milk aggregators to raise new aspects based on their everyday activities in milk sourcing. Allowing the respondents to direct the interview facilitated a more natural conversation and allowed them to freely talk about their daily practices and experiences in milk sourcing.

Participatory workshops were conducted in Njombe, Rungwe and Dar es Salaam to validate findings from the research and elaborate on the relationships between actors within the broader sectoral/political-economic contexts. During the workshops, I presented preliminary results and allowed the participants to check the reliability of the results. In each district, relevant stakeholders from the government, development partners, private sector players, farmer organisations and other service providers were invited, eliciting data on the local systems, power relations between business actors, competition, and local-level alliances. A national validation workshop was also held, including national-level government officials, farmers, and development organisation representatives from all the study districts to validate findings and provide a national-level outlook.

Quantitative data were cleaned and analysed using STATA version 15. Statistical analysis, descriptive analysis and econometric modelling approaches were employed in chapters 2 and 3

(further elaborated in the subsequent chapters). Chapter 2 used multivariate cluster analysis to evaluate within-group similarities and differences between groups. Chapter 3 uses econometric modelling to understand the relationship between dairy intensification and livelihood diversity. Qualitative data derived from key informant interviews, case studies and desk research were analysed using an iterative process following Auerbach and Silverstein (2003). The iterative process included coding, detecting themes and patterns, and repeating the entire process. Qualitative data were analysed using ATLAS.ti.

1.6 Thesis outline

This thesis comprises six chapters (Figure 1.2), a general introduction, four empirical chapters and a general discussion. **Chapter 1** provides a general introduction, research objectives, theoretical grounding and methodological choices taken during this study.

Chapter 2 identifies pathways for scaling LED that better account for divergent smallholder capabilities, strategies, and interests. The chapter analyses heterogeneity in farmers' assets, incomes and production goals and links this to their level of uptake of LED practices. The chapter concludes that a more careful consideration of farmer differentiation is an essential first step to anticipating the diverse socio-economic determinants of adopting LED.

Chapter 3 investigates the effects of dairy specialisation on income, dietary and wealth diversities to contribute to ongoing debates around livestock intensification and livelihood diversification in mixed-crop livestock systems. Understanding this relationship is essential in East Africa, where mixed crop-livestock systems are critical in coping with climate change. This analysis also helps to understand the socio-economic benefits of dairy intensification.

Chapter 4 evaluates sub-national economic configurations in which various actors' capacities and resources combine and shape the conditions for realising LED. This chapter takes the multiplicity of development pathways to explore the conditions under which LED strategies may have material consequences on the ground. I demonstrate that inclusiveness is not only at the level of individuals – there is also a need to consider spatial aspects that shape inclusive development.

Chapter 5 evaluates a business practice that builds a viable market linkage with pastoralists. The research is based on a case study that highlights the alignment of pastoralists' production goals and traders' practices in sourcing milk. The analysis also highlights the need to consider

endogenous development solutions toward inclusive LED. In doing so, I demonstrate that agency is grounded in performance.

Chapter 6 synthesises the insights and findings from the four empirical chapters. It critically discusses challenges associated with the top-down implementation of global technocentric policies. It shows why an understanding of local context and plural pathways in adopting new technologies should be considered. Finally, the chapter zooms out to discuss the relevance of these aspects to intervention design and policy.

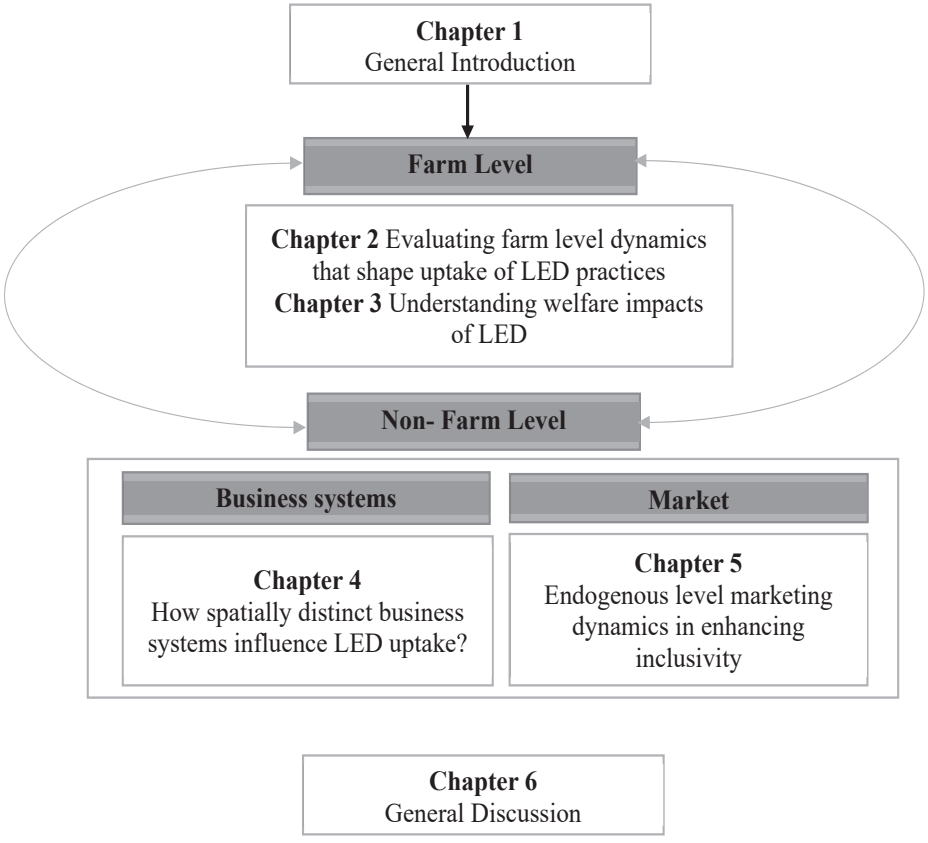

Figure 1.2. Thesis outline and positioning of the chapters in terms of levels of study

Chapter 2

Pathways toward inclusive low-emission dairy development in Tanzania: producer heterogeneity and implications for intervention design

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2 Pathways toward inclusive low-emission dairy development in Tanzania: producer heterogeneity and implications for intervention design

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Abstract

Reducing greenhouse gas (GHG) emissions from the agriculture sector – especially livestock – through low-emission development Strategies (LED) has attracted global attention. However, producers rarely prioritise emission reduction in their day-to-day practices, resulting in a mismatch between global and national environmental policies and local development interests. This raises the urgency of identifying overlapping solution spaces that would address global and national environmental targets and farmers' production goals. The objective of this study is to identify pathways for scaling LED that better account for divergent smallholder capabilities, strategies, and interests. A multivariate cluster analysis was used to evaluate producer heterogeneity. The analysis utilised data from 1,176 household surveys in Tanzania. Informed by these results, stakeholder workshops were held to identify how each group is uniquely constrained in the adoption of LED practices and viable paths forward. Our results reveal six distinct farmer types, distinguishable by their asset base, livestock ownership, cattle breeds, access to market and income diversity. The six groups presented three levels of LED uptake, high, moderate and low. Variants of technological packages and market-based interventions, access to better quality inputs and extension services will be more impactful when correctly matched to producers' asset portfolios, interests and needs for the high and moderately intensifying producers. However, interventions that address both the knowledge and resource gaps for producers who demonstrate low uptake of LED will be more appropriate. Achieving GHG reduction will be modest from already intensifying groups and the low uptake groups, while moderately intensifying groups present the highest leverage for increased GHG reduction potential. This highlights how taking a food system approach rather than a technological package would be more beneficial, especially in targeting groups that are not interested in LED. This study challenges the conceptualisation of LED as a simple technological fix. We demonstrate that LED, as currently conceptualised, is not equally accessible or appealing to everyone. Consequently, successful LED uptake is contingent on donor and state ability to match LED strategies, local development priorities and food systems objectives to develop more targeted needs-driven implementation pathways.

2.1 Introduction

The potential to mitigate greenhouse gas (GHG) emissions in the agricultural sector is increasingly recognised in global environmental policy (Lipper, 2014; Thornton, 2010). The livestock sector is often seen as a promising avenue for reducing GHG emission intensities because it accounts for 65% of global agricultural GHG emissions (Thornton and Herrero, 2010; Tubiello et al., 2014). Achieving this reduction involves increasing consumable outputs per unit of GHG emission through productivity and efficiency enhancements (Havlík et al., 2014; Herrero et al., 2016). However, smallholder farmers' management priorities rarely account for GHG emissions. Instead, smallholders' livestock-keeping practices are driven by a variety of objectives, including profit, but also other economic and social considerations (Weiler et al., 2014). Still, farmer and low-emission development (LED) priorities are not irreconcilable because emission reductions need not result in economic compromise (Havlík et al., 2014). The adoption of more intensive production practices consistent with LED generally helps raise agricultural productivity (ibid). Such practices can, therefore, both increase producer incomes and reduce GHG emissions per unit of production (Herrero et al., 2016; Thornton and Herrero, 2010).

For the livestock sector, so-called "triple-win LED outcomes" can be achieved through productivity gains, improved profitability and reduced GHG emissions intensities. However, LED often remains an overarching goal that lacks clear implementation strategies and does not always correspond with local interests and priorities (Garnett et al., 2013). The typical mismatch between global and national environmental policy and rural development priorities thus raises the need to identify solution spaces (Michalscheck et al., 2018; Ollenburger et al., 2018) where global and national environmental targets overlap with farmers' production goals, capabilities and ambitions. In practice, many LED strategies focus on technical fixes but fail to adequately account for the socio-institutional dimensions of production and distribution that shape the uptake of proposed technologies (Herrero et al., 2016; Taylor, 2018).

Technocentric approaches to LED have several limitations. Firstly, most technocentric LED interventions take a "one-size-fits-all" approach to extension support, failing to appreciate how farmer heterogeneity affects the implementation of new practices. Secondly, technocentric LED interventions tend to be designed around the assumption that intensification and productivity gains produce socio-economic co-benefits for all producers. This assumption ignores the fact that returns

from intensification do not necessarily meet the financial and social interests of all producers equally. The benefits derived from and costs associated with intensification are often unevenly distributed across social classes and categories (Tavenner et al., 2019). To ameliorate the distributional risks associated with technocratic approaches, many scholars have recently begun to explore methodological and analytical approaches that help to account for the diversity of farmers and adoption constraints (Kuivanen et al., 2016; Schoneveld, 2018; Verkaart et al., 2018).

The objective of this study is to identify pathways for scaling LED that better account for divergent smallholder capabilities, strategies and interests. With donor and government LED investments in the livestock sector on the rise, more deliberate consideration of farmer differentiation is an essential first step to anticipating the diverse socio-economic determinants of adoption and programmatic success. Most empirical studies rely on regression analyses to identify factors that influence adoption rates (Prokopy et al. 2008). Such studies, however, rarely capture how barriers to adoption vary across different producer groups and space. By homogenising farmers, they consequently often suffer from a composition problem by not accounting for diversity. This raises very real questions about the policy relevance of many extant adoption studies. This study aims to advance our understanding of differentiated adoption barriers through the development of a typology of dairy farmers. We use this typology to examine how adoption rates of key LED practices differ across producer groups and identify adoption barriers unique to each group. We do this using a three-staged approach. First, we analyse farmer heterogeneity using a multivariate cluster analysis that draws exclusively on socio-economic variables. Second, we analyse the extent to which farmers in the different clusters have thus far adopted different LED practices. Third, we analyse what constrains and incentivises the adoption of LED practices within each group. This approach is designed to facilitate the identification of more targeted and actor-disaggregated intervention strategies and LED policies.

In doing so, this article not only produces knowledge that is more relevant to LED policy-making but also advances the literature on smallholder heterogeneity (Alvarez et al., 2018; Dorward et al., 2009; Tittonell et al., 2015) and LED in smallholder livestock systems (Paul et al., 2021; Ndung'u et al., 2019; Ericksen and Crane, 2018; Herrero et al., 2016). Although a small number of studies have previously explored the relationship between farmer heterogeneity and intervention designs (e.g., Schoneveld et al., 2019; Verkaart et al., 2018), this article is, to our knowledge, the first attempt to explore the interface between farmer heterogeneity and LED. While results reveal how

smallholder barriers to uptake of LED practices do indeed differ profoundly across farmer sub-groups, they also point to several structural adoption barriers that may undermine the efficacy of LED interventions more generally. We also show that some sub-groups are easier to target for "quick wins", while others will require more long-term support. This article finally explores how LED interventions can become more impactful by anticipating farmer heterogeneity and adopting a food systems perspective.

2.2 Background

2.2.1 Smallholder transformation

The uptake of LED in agriculture demands a transformation of existing production systems. Such transformations demand change both at the institutional and societal levels (Hebinck et al., 2018). Transformation involves "changes in structural, functional, relational, and cognitive aspects of socio-technical-ecological systems that lead to new outcomes" (Patterson et al., 2017, p. 2). This emphasises a societal change beyond mere technocentric solutions (Geels, 2002). Technocratic approaches to agricultural transformation have been widely criticised because they fail to capture the dynamism and contingencies of development, including social differentiation and local institutional frameworks surrounding transformation and sustainability (Abrol, 2005; Berkhout et al., 2005; Leach et al., 2010a).

Various conceptual approaches have been employed to analyse societal transformation processes (see Patterson et al., 2017 for more details). This study follows the transformative pathways to sustainability approach developed by Leach et al. (2010), which depicts transformation as a process that is transitional and continuously shaped by social feedback, as well as by varying spatial and structural contexts (Leach et al., 2010a; Lindahl et al., 2016). It emphasises that transformation is political, complex, dynamic, and involves questioning dominant narratives (Leach et al., 2010a). Consequently, no single transformation pathway can fit all situations. Presuming homogeneity of actors within a system is, therefore, ill-advised (Leach et al., 2010a; Stringer et al., 2020). This implies that multiple narratives of change co-exist within systems, with successful transformations typically involving diverse "pathways" for different individuals (Scoones et al., 2020b).

We use the pathways approach to understand how different farmers' interactions with various structural and institutional conditions differentiate the uptake of LED practices. While households differ in their motivations, strategies, socio-economic characteristics and ability to access productive resources such as land, labour and inputs, they are also confronted with trade-offs concerning resource (re)allocation and production decisions (Salmon et al., 2018). For instance, in areas with productive and significant grazing lands, the urgency of on-farm fodder production is reduced (Clay and King, 2019). Vast distances from the homestead where cows are kept to households' fields can make the cut-and-carry fodder grass production extremely labour-intensive. It is easier to intensify in the higher altitude conditions, where households have access to smaller pieces of land, reside in closer proximity to their farms, and lower temperatures support the rearing of crossbred cows. On the other hand, keeping fewer crossbred cows might be more difficult in lower, more arid regions dominated by pastoralists who keep large numbers of local cattle both for economic and cultural reasons. This highlights how household uptake of LED practices is highly context-specific (Clay and King, 2019). A weak or oversimplified understanding of the local processes that shape the viability of alternative transformation pathways may lead to the development of unsuitable interventions that target the wrong farmers with the wrong technologies. It may also exacerbate processes of social differentiation and entrench existing inequalities when interventions inadvertently privilege better-resourced and capacitated farmers.

2.2.2 Conceptualising smallholder heterogeneity and implications of LED

Although the broader pathways approach explains transformation broadly, it is yet to be comprehensively operationalised. To further our understanding of farmer heterogeneity, we, therefore, look elsewhere, drawing particularly on the framework from Doward et al. (2009). The framework is based on the simple supposition that households aspire to retain and/or advance their current wellbeing. Dorward proposes three distinct household strategies: "hanging in," "stepping up", and "stepping out." As others have shown, unpacking such strategies can make valuable contributions to explaining smallholder adoption behaviours (Schoneveld et al., 2019; Verkaart et al., 2018). Households "hanging in" are constrained and less likely to innovate on their agriculture activities to minimise risk and maintain their current livelihood level. Households that are "stepping up" can invest resources in existing agricultural activities, often motivated to accumulate assets through productivity enhancements. Finally, households that are "stepping out" are accumulating and diversifying into non-farm livelihood activities, often to transition out of

agriculture (Dorward et al. 2009). Over the years, additional strategies not captured by Dorward (2009) have been proposed. Schoneveld et al. (2019), for example, show that increasingly more urbanised households are "moving through" (e.g., entering agriculture for more speculative purposes before moving out) while some households are "moving in". These are generally new entrants to agriculture, often using non-farm income to invest in agriculture in response to a specific opportunity in the sector.

Accounting for such strategies helps development practitioners depart from "one-size-fits-all" approaches (Alvarez et al., 2018; Schoneveld et al., 2019; Thornton et al., 2018; Tittonell, 2014). For example, farmers "stepping up" are more inclined to respond to market-based interventions that provide offtake guarantees, while farmers "hanging in" often particularly benefit from capacity-building activities (Verkaart et al., 2018). Such approaches are increasingly gaining traction in the donor community in recognition of the sub-optimal results produced by "one-size-fits-all" approaches (see, for example, DFID 2015). That said, while the strategies proposed by Dorward et al. (2009) and others are useful heuristics for interpreting farmer heterogeneity, farmer strategies are not our entry point. Instead, we use Dorward et al. 's (2009) framework to help interpret results from a more data-driven farmer typology development approach that does not attempt to identify the strategies *ex-ante*, but inductively by examining key strategy constructs. This includes livelihood activities, capabilities and assets (Dorward et al., 2009; Ellis, 1998). It, therefore, enables us to identify additional or variations of previously identified strategies that are unique to the dairy sector, Tanzania and/or LED.

2.3 Materials and methods

2.3.1 National context and study sites

The study was conducted in Tanzania, selected for its dairy production potential, large milk productivity gap, national milk deficit and per capita consumption gap (Katjiuongua and Nelgen, 2014; Nell et al., 2014). Tanzania has the third-largest cattle herd in Africa, and the Tanzanian government has identified dairy as a priority growth sector in its Livestock Master Plan (Michael et al., 2018). However, the country experiences a structural milk deficit and is a net importer of dairy products (Nell et al., 2014). In Tanzania, the livestock sector contributes 13% to the agricultural gross domestic product (GDP) and 5.9% to the national GDP (Makoni, Mwai, Redda, Zijpp, & Lee, 2014). Approximately one-third of the livestock sector's contribution to GDP comes

from the dairy sector (TDB, 2018). With Tanzanians consuming only 45 litres of milk per year (TDB, 2018), much of the Tanzanian population consumes a fraction of FAO's recommended 200 litres per annum (Nell et al., 2014). Milk predominantly originates from comparatively unproductive local cattle breeds, which account for 70% of the total national milk production, kept within pastoral and semi-intensive production systems (Michael et al., 2018).

Even though the sector's contribution to rural development is well-recognised, it is increasingly attracting attention for its high GHG emission intensities (FAO, 2019). Based on Tanzania's Nationally Determined Contribution (NDC), the country seeks to reduce its GHG emissions by 10 and 20% by 2030 over the business-as-usual scenario (URT, 2015a). Emissions from livestock account for approximately 72.5% of Tanzania's total emissions from the agricultural sector (Irish, 2018, p. 12). This is slightly higher than the global average of 65% (Tubiello et al., 2014). In Tanzania, milk production from the dairy sector emits approximately 28.8 million tons of carbon dioxide (CO_2) equivalent (eq.) (FAO, 2019). A study conducted by FAO (2019) in Tanzania noted that "the GHG profile of milk is dominated by methane 95.5 %, while the nitrous oxide (N2O) and (CO_2) contribute 4.2 % and 0.3 % of the total emissions, respectively" (FAO, 2019, p. 9). The average national emission intensity for milk is 19.9 kg CO_2 eq./kg Fat and Protein Corrected Milk (FPCM) (FAO, 2019). Previous research has shown that technical interventions have the potential to increase milk production by 29% for improved systems while reducing GHG emissions by 46% (ibid). Because of their low degree of intensification, traditional dairy production systems have the potential to increase milk output by 56% and decrease emission intensities by 54% (FAO, 2019).

Research activities were performed across four districts and provinces, namely Mvomero district in the Morogoro region, Mufindi district in the Iringa region, Njombe district in the Njombe region, and Rungwe district in the Mbeya region (Figure 2.1). These sites were selected based on their distinctive biophysical and social conditions, thereby ensuring that a diversity of geographies and production systems representative of Tanzania are captured.

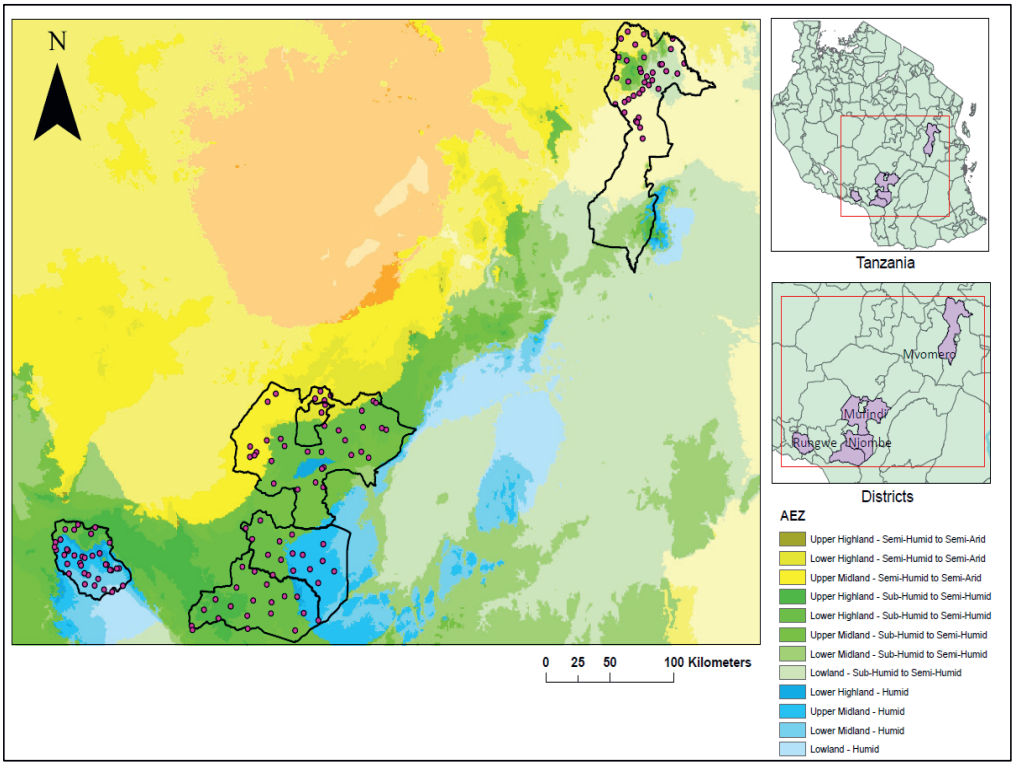

Figure 2.1. Tanzania study sites

The salient characteristics of the four districts are summarised in Table 2.1. Characteristics of each of the four districts. Mvomero has a mixture of pastoralists and mixed crop farmers, representing a range of systems from extensive grazing to intensive dairy (URT, 2018). No major processors collect milk directly from producers from this district. Mufindi's livestock keepers keep their cattle within semi-intensive systems, and the milk market is poorly developed due to seasonal milk deficits. Most of the milk is therefore marketed locally (URT, 2015b). Most households prioritise crop production, with cows primarily functioning as a source of traction and manure. Njombe, in contrast, has experienced decades of dairy development interventions (URT, 2016a). This produced numerous dynamic dairy farmer organisations and both commercial and community co-owned milk processing plants. Finally, Rungwe is characterised by highly commercial and competitive milk markets, with most households owning a cow (URT, 2015c). The district has a large milk surplus, with many milk buyers, both formal and informal, and commercial processors collecting milk.

Table 2.1. Characteristics of each of the four districts

Characteristic	Unit	Rungwe	Njombe	Mufindi	Mvomero
Area	Km^2	2078	6366	7123	7,325
Population	Persons	339,157	216,010	317,731	312,109
Population density	Persons/km^2	163	34	45	43
Indigenous cattle	Number	22,804	59,195	81,162	65,064
Crossbred cattle	Number	55,337	7,784	6,140	1,923
Grazing land	Area in ha	0 ha	32,824 ha	66,223	15,620 ha
Livestock production systems	From most to least frequent	intensive semi-intensive	Intensive Extensive	Semi-intensive Extensive	Extensive systems Semi-intensive

Source: District socio-economic profiles: Mufindi (URT, 2013a), Mvomero (URT, 2018), Njombe (URT, 2014a, 2013a), Rungwe (URT, 2015c, 2015d).

2.3.2 Sampling

We sampled households using a two-stage approach. In the first stage, biophysical clusters were developed to ensure that variability in production systems not only across but also within districts was sufficiently captured and accounted for. The second stage entailed a random selection of respondents within villages representative of each of the biophysical clusters identified under the first stage.

The development of biophysical clusters involved cluster analysis using the k-means algorithm (Hartigan and Wong, 1979). Cluster analysis was performed using spatially explicit data on rainfall, temperature and elevation. These variables are known to shape dairy farming suitability and systems (e.g., Jesse et al., 2020). To identify the appropriate number of clusters per district, the "natural breaks" feature on QGIS was used. This yielded a three-cluster solution with high between-cluster variability and low within-cluster variability. The three clusters comprise low (high temperature, low rainfall, and elevation), medium (ranked moderately on all the parameters) and high (low temperature, high rainfall and elevation) suitability (Figure 2.2).

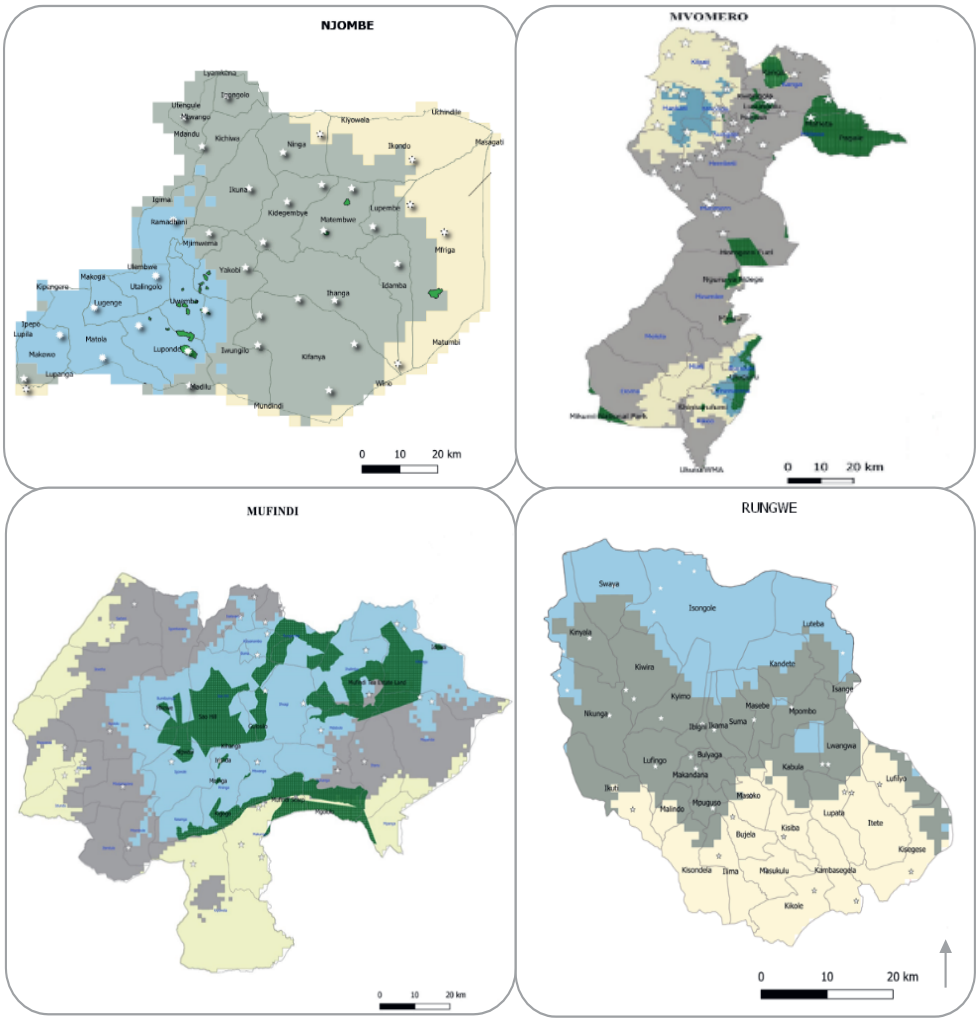

Figure 2.2. Agroecological clusters across the four study sites

Note: Blue colour denotes the high cluster, grey the mid cluster and cream the low cluster, while green denotes the forested land, and the white stars denote the sampled villages.

Legend: Low Mid High Forest Selected villages

Table 2.2. Characteristics of each cluster within the four districts

District	Cluster	% area	Number of points	Temperature	Altitude	Rainfall
Rungwe	Low	33	12	20.6–24.5	498–1,134	900–1,270
Rungwe	Mid	42	15	16.9–20.6	1,134–1,794	1,270–1,670
Rungwe	High	25	9	11.6–16.9	1,794–2,760	1,670–2,070
Mvomero	Low	8	3	23.0–27.0	200–700	600–800
Mvomero	Mid	22	8	19.0–23.0	700–1,300	800–1,000
Mvomero	High	69	25	12.0–19.0	1,300–2,900	1,000–1,500
Mufindi	Low	25	9	19.2–22.8	800–1,400	620–840
Mufindi	Mid	33	12	17.6–19.2	1,400–1,700	840–1,060
Mufindi	High	42	15	15.9–17.6	1,700–2,100	1,060–1,410
Njombe	Low	17	6	19.7–23	442–1,533	1,280–1,480
Njombe	Mid	61	22	16.5–19.7	1,534–1,733	1,120–1,280
Njombe	High	22	8	13.3–16.5	1,733-2,491	900–1,120

Villages were sampled by distributing 36 points across the three clusters in each of the four districts. The village closest to a given point was selected for inclusion in the sample. Point assignment to each cluster depended on cluster area (e.g., more points were placed in larger clusters). This stratified sampling approach sought to ensure population representativeness, as well as to capture socio-economic variation across space.

In the selected villages, a sampling frame was constructed, with the help of village elders, which captured all households owning an adult cow producing milk or an in-calf heifer. The sample size was estimated following the Yamane (1967) formula, later applied by Israel (2003) and Kihoro (2016), which is used when the population size is known.

$$n = \frac{N}{1+N(e^2)} \qquad \textit{Equation 2.1}$$

Where n = sample size, N = total (targeted) population, and e is the confidence level (5%). For instance, in Rungwe, the total number of households with a cow was 1,425, which resulted in a sample size of 312, this was rounded off to 350 to accommodate outliers or data quality issues. A total of 350 households with a cow were randomly selected in Rungwe and Njombe and 250 in Mvomero and Mufindi, as these districts also had fewer households keeping cows. A total of 1,200 households were surveyed in the four districts using a structured questionnaire.

2.3.3 Data collection

This research was performed under the IFAD-funded project entitled “Greening Livestock: Incentive-based Interventions for Reducing the Climate Impact of Livestock in East Africa”. Data

was collected using a household survey instrument that was loosely based on the Rural Household Multi-Indicator Survey (RHOMIS) (Hammond et al., 2017). Our instrument captured the following types of data: (1) household demographic characteristics; (2) household assets; (3) livelihood portfolio; (4) management practices; (5) milk marketing practices; and (6) producer perceptions of climate change and the impacts of dairy to the environment. Data were collected between December 2017 and June 2018 during the wet season across all study sites. A total of 1200 households were surveyed. However, after data cleaning and removal of outliers, results from 1176 households were retained for the cluster analysis: 350 from Rungwe, 343 from Njombe, 240 from Mvomero and 243 from Mufindi.

2.3.4 Analytical framework

The following sections describe our three-staged analytical framework, following the three steps outlined in the introduction.

Developing farmers typologies

A quantitative data-driven approach to developing farmer typologies was employed, complemented by participatory validation workshops (see Section 3.4.3 for more information). As discussed above, the farmer typology was developed using only socio-economic data, such as assets, capabilities and income sources. This methodology departs from many farm systems approaches (Kuivanen et al., 2016), which combine both farmer characteristics, farm characteristics and farming activities. By not combining practices and farmer characteristics, one is better able to explore the relationship between the two and how these are influenced by confounding factors (Schoneveld et al., 2019).

A multivariate cluster analysis was done using the DAISY package in R (3.5.1). DAISY uses Gower distance and partitioning around medoids (PAM) to produce clusters that have the greatest within-group similarity and greatest dissimilarity between groups. Because the survey data comprised mixed data types (continuous, categorical, binary), k-means classification would not be appropriate for this analysis. To obtain appropriate cluster numbers, silhouette width from PAM and dendrograms were used (Mooi and Sarstedt, 2010). We did not conduct a principal component analysis (PCA) before the cluster analysis to preserve the data structure.

A total of 18 socioeconomic variables were used for the clustering (Table 2.3). The variables included demographic variables (Alvarez et al., 2018) and variables that capture livelihood

activities and household asset endowments (Dorward et al., 2009; Tittonell, 2014). The four asset variables include the asset index (constructed following the Filmer and Pritchett 2001 methodology), Tropical Livestock Unit (TLU) (following Njuki et al., (2011)), total land owned by the household and group membership as a proxy for social capital. Livelihood activities were calculated as a dummy variable from households representing whether a household was engaged in that activity or not (Schoneveld et al., 2019).

Table 2.3. Variables used to cluster producers

Variable	Mean (SD)	Description	Proxy for
Education	3.05 (1.04)	Highest education of Household head Ordinal with 6 levels (0= No formal education, 1=primary 1–3, 2=primary 4–7, 3=secondary 1–4,4=A-levels form 5–6, 5= collage, 6=University)	Demographic
Age [years]	51.03 (12.04)	Age of the household head [years]	Demographic
Gender [% male]	88.77 (31.58)	Gender of the household head [1=male 0=female]	Demographic
Household size [number]	5.83 (2.31)	Household members 16–65 years [No]	Demographic
Ethnicity [% indigenous]	78.31 (41.22)	Dummy for ethnicity [1=yes, 0=no]	Demographic
Land [acres]	10.65 (14.28)	Total land holding [acres]	Asset endowment
TLU [index]	9.51 (15.99)	TLU score [score]	Asset endowment
Asset [index]	0.53 (0.15)	Asset index [score]	Asset endowment
Group membership [%]	42.26 (49.41)	Dummy group membership [1=yes, 0=no]	Livelihood activities
Dairy sales [%]	68.19 (46.59)	Dummy income dairy [1=yes, 0=no]	Livelihood activities
Food crop [%]	71.17 (45.31)	Dummy food crops revenue [1=yes, 0=no]	Livelihood activities
Livestock sales [%]	77.22 (41.96)	Dummy livestock revenue [1=yes, 0=no]	Livelihood activities
Casual employment [%]	10.20 (30.28)	Dummy casual income [1=yes, 0=no]	Livelihood activities
Business [%]	58.12 (19.23)	Dummy off-farm business [1=yes, 0=no]	Livelihood activities
Formal income [%]	11.13 (31.47)	Dummy off-farm formal [1=yes, 0=no]	Livelihood activities
Forest plantation [%]	37.50 (48.43)	Dummy forest plantations income [1=yes, 0=no]	Livelihood activities
Cash crop revenue [%]	68.02 (46.65)	Dummy cash crop revenue [1=yes, 0=no]	Livelihood activities
Other income [%]	22.27 (41.62	Dummy for non-labour income [remittances, dividends and pension]	Livelihood activities

Note: Values in Brackets are standard errors

Clusters were compared not only using the variables included in the multivariate analysis but also using variables that condition the uptake of LED practices. This includes household income,

access to markets and average milk price, which represents investment capacity and market articulation (Michalscheck et al., 2018; Tittonell et al., 2010)

LED practices at the household level

Indicators for households' LED practices were guided by their contribution to productivity (intensification) and emission intensities, as discussed by Ericksen and Crane (2018). The technical practices were grouped into the following three categories: *(i) Improved feed quality and quantity,* such as fodder production and feeding concentrates, were used to denote the provision of sufficient high-quality and high-protein feed to cows (Thornton and Herrero, 2010). Further, full-time water access and feed conservation were used as proxies for the management of dry season water and feed availability constraints. A study by FAO (2019) conducted in Tanzania demonstrated that improved feeding practices could decrease emission intensities by 8–35%. Additionally, zero-grazing, i.e. confining animals to limited physical space in which they are fed and milked, was used as a proxy for improved efficiency in animal feeding and husbandry (Aguirre-Villegas et al., 2017).

(ii) *Improved animal health and husbandry practices*: we use deworming, spraying, use of artificial insemination and improved bulls for insemination and calving interval, as proxies for animal health and good husbandry practices. Improved animal health through deworming and tick management (spraying/dipping) can significantly improve productivity and reduce emission intensities by reducing mortality and morbidity and enabling animals to invest energy in milk production. Having an appropriate calving interval between 12 to 14 months and proper breeding strategies helps in maintaining productivity and can reduce emission intensities by 20–35% (FAO, 2019).

(iii) Proper *manure storage and management* can reduce emissions from manure by up to 90% by reducing anaerobic decomposition (Ericksen and Crane, 2018). Time taken before incorporating manure into soils and the use of biodigesters were used as proxies for optimal manure management. Appropriate use of manure on soils can contribute to more efficient nutrient use, soil quality and crop productivity while replacing synthetic fertilisers and their associated emissions (Chadwick et al., 2011). Use of biodigesters that capture methane and convert this into energy also significantly reduce emissions associated with manure, while also contributing to household energy needs and replacing non-renewable alternatives (Chadwick et al., 2011; Herrero et al., 2016). Table 2.4 describes the variables. To facilitate comparison and interpretation, we mainly use dummy

variables. This data on LED practices were subsequently used to compare the degree of adoption across the clusters. Further, a composite index was developed using factor analysis. This was used to compare the adoption of LED across various marketing options and farmer types.

Table 2.4. Low-emission practices at the household level

	Variable	Mean (SD)	Description
Feeding	Feed conservation [%]	11.05 (31.37)	Dummy variable for practising feed conservation
	Fulltime water access [%]	18.28 (38.66)	Dummy variable for cows having fulltime water access
	Grow fodder [%]	42.68 (49.48)	Dummy variable for whether household grow improved fodder
	Feed concentrates [%]	71.76 (45.03)	Dummy variable for households that feed cattle concentrates
	Zero grazing [%]	54.33 (49.83)	Dummy variable for households that practice zero-grazing
Animal health and husbandry	Crossbred cows [% improved]	62.33 (47.03)	The proportion of crossbred cows
	Deworm within every three months [%]	41.41(49.27)	Dummy variable for deworming cattle at least once every three months
	Spray fortnightly [%]	61.39 (48.70)	Dummy variable for spraying/dipping cattle every fortnight
	Inseminate using improved bull [%]	60.28 (48.95)	Dummy variable for households using improved bulls for insemination
	Inseminate using AI [%]	3.91(19.39)	Dummy variable for households using AI for insemination
	Calving interval below 14 months [%]	53.99 (49.86)	Dummy variable for households with a calving interval below 14 months
Manure management	Use manure on the farm within three months [%]	15.98 (36.66)	Dummy variable for the use of manure on the farm within three months
	Biodigester [%]	2.12 (14.43)	Dummy variable for households with a functional bio-digester

Note: Values in Brackets are standard errors

Validation and barriers to uptake of LED practices

The cluster analysis results were validated with a subset of research participants and relevant experts through multi-stakeholder workshops conducted in February 2019. Expert participants included a mix of representatives from the government, local development organisations, farmer organisations and dairy-relevant enterprises. In these workshops, the household typologies were presented, and participants reflected on how well they reflected their realities. The validation workshops were also used to identify the different barriers to the uptake of practices that should be accounted for in LED intervention design. Participants were asked to reflect on adoption barriers particular to each cluster and how farmers in each cluster are likely to respond to different

incentive mechanisms. This enabled us to differentiate between structural and cluster-specific barriers to the uptake of LED practices. A total of 110 representatives from the Njombe and Rungwe districts were involved in these workshops. Although similar workshops were not held in Mufindi and Mvomero due to budgetary constraints, stakeholders from these districts participated in a national workshop where their views were incorporated.

2.4 Results

2.4.1 Farmer typologies

The first stage of analysis produced six distinctive clusters of farmers through cluster analysis. The largest cluster contained 281 households (cluster 4), representing 24% of the total sample population, and the smallest cluster of 109 households (cluster 6), representing 9% of the sampled population. The demographic characteristics of each cluster are summarised Table 2.5 and Figure 2.3. This data shows that cluster membership is strongly influenced by wealth indicators, whether farmers are engaged in business activities, whether they are part of a farmer's organisation, and whether income is derived from dairy production. Based on these descriptive statistics and workshop results, we characterise each cluster as forth:

Cluster 1: Subsistence farmers

This cluster of farmers has the highest proportion of respondents with no formal education (15.72%). They also have the lowest asset index (0.45) and the lowest household annual income (Figure 2.3). Respondents in this cluster do not engage in milk sales and any off-farm business activities. Almost two-thirds of income is obtained through cultivation activities (e.g., cash crops, food crops and/or timber) (Figure 2.4). This cluster, however, has the highest TLU (13.29), but only half of the cluster (49%) depends on livestock sales despite owning significant livestock. This cluster is, therefore, comparatively poor and vulnerable, with livestock mostly meeting the consumptive needs of the households, functioning foremost as a safety net.

Cluster 2: Diversified farmers

This cluster of farmers is comparatively diversified. Farmers in this cluster have multiple sources of income, with all farmers deriving an income from both dairy and off-farm business activities. While most households are engaged in a variety of crop production activities (61%), dairy (100%) and business (100%) are the primary sources of income. The cluster is comparatively affluent, scoring highly on the asset index (0.59), having some of the highest annual incomes, and owning

significant TLU and land. None of the farmers in this cluster is engaged in farmer groups, suggesting prioritisation of off-farm economic activities.

Table 2.5. Demographic characteristics of farmer groups

Variables	1	2	3	4	5	6	Chi/ F-Statistic
Total cluster size (n)	229	132	258	281	167	109	
Demographics							
Education ordinal	2.72	3.21	2.95	3.11	3.11	2.90	35.0***
Gender of HHH [% male]	90.39	91.66	90.00	83.15	90.41	90.82	11.49
Age HHH [Years]	51.79	50.14	50.75	52.25	50.71	48.56	11.2
Total land [Acres]	8.70	10.86	8.65	12.92	14.19	7.95	58.4***
Wealth index [Score]	0.45	0.59	0.52	0.57	0.60	0.49	30.4***
TLU [Score]	13.29	9.33	11.56	5.67	6.61	11.34	62.5***
Household size [number of members]	5.99	6.02	5.88	5.46	5.70	6.29	2.80
Origin of the household head [% indigenous]	83.84	74.24	70.38	82.43	74.25	86.23	21.4**
Dummy casual income [% yes]	7.86	0.45	9.23	15.05	10.17	11.92	13.46
Dummy formal income [% yes]	6.55	15.91	12.69	14.33	9.58	5.50	15.24**
Dummy non-labour-off-farm income [% yes]	16.15	20.45	19.23	28.13	28.14	20.18	3.24
Dummy revenue livestock [%]	49.34	82.57	83.07	91.76	92.22	55.04	193.9***

*** significant at 1% level of significance; ** significant at 5% level of significance; * significant at 10% level of significance.

Cluster 3: Livestock-dependent farmers

We consider this cluster as being livestock-dependent due to its heavy reliance on income from dairy and other livestock activities and high TLU ownership. With regard to livelihood portfolios, respondents in this cluster depend on livestock for their income. All the respondents (100%) derive an income from dairy, followed by income from livestock sales (83%). Approximately 59% of household income originates from dairy and livestock sales (Figure 2.4). The cluster is average in asset ownership. This is the only cluster where income from dairy comprises most of the household income. None of the respondents in this cluster have an off-farm business income.

Cluster 4: Farm specialists

This cluster is characterised by high on-farm diversification, with significant dependency on farm-based activities (84% of income). Farmers in this cluster cultivate the largest number of different cash and food crops and timber, although dairy is the backbone of their livelihoods. On average,

farmers in this cluster own large areas of land (12.9 acres), only exceeded by Cluster 5. The importance of agriculture is reflected by all farmers being engaged in farmer groups.

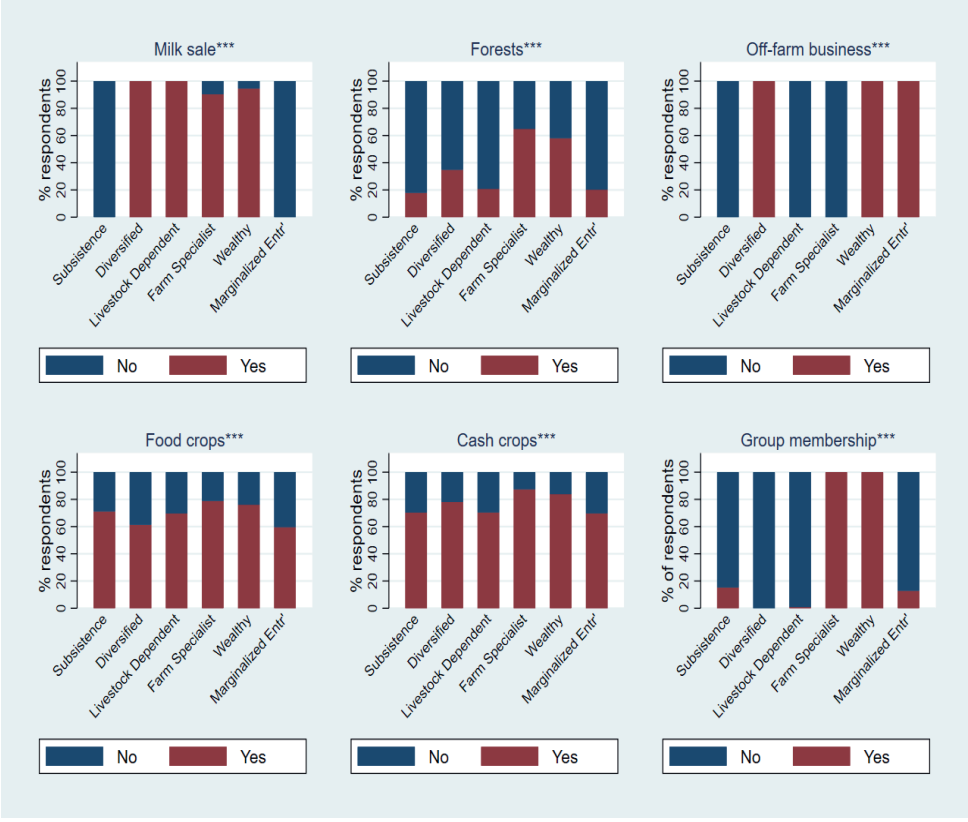

Figure 2.3. Livelihood activities across the six clusters

Note: X-axis Marginalised Entr represents Marginalised Entrepreneurs

*** significant at 1%, ** significant at 5%, * significant at 10% level of significance

Cluster 5: Wealthy

Farmers in this cluster are the wealthiest. They rank highest on the asset index (0.60) and have the largest average land size (14.2 acres). Additionally, they have access to multiple sources of income, both on-farm and off-farm, with all (100%) of the respondents in this cluster having an off-farm business income. They also derive an income from cash crops (58%) and/or food crop sales (76%). Livelihood composition in this cluster is similar to Cluster 2, although business activities are of lesser importance than on-farm activities. This is reflected in widespread participation in farmer organisations.

Cluster 6: Marginalised entrepreneurs

Respondents in this cluster can be characterised as non-dairy, off-farm entrepreneurs because none of the respondents derives income from dairy, while all derive income from off-farm, notably business activities. Farmers in this cluster also tend to earn a lower income, possess less land (7.95 acres), and be less asset endowed than farmers in most other clusters, except subsistence farmers, although they do own significant TLU (11.34). Off-farm activities take priority over dairy for members of this cluster.

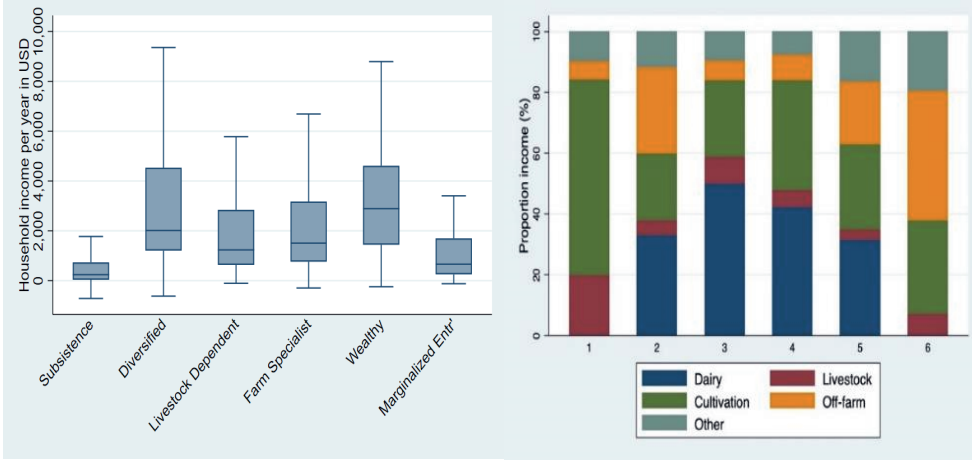

Figure 2.4. Total household income by cluster

Note: The X-axis represents the clusters; 1=Subsistence Farmers, 2=Diversified Farmers, 3= Livestock Dependent, 4= Farm Specialist, 5= Wealthy Farmers, and 6 = Marginalised Entrepreneurs. Note: Other income includes remittances, pensions and dividends; Off-farm includes business activities and employment; Cultivation of cash crops, food crops and timber. 1USD= 2300TZS as of the time of the survey in 2018.

2.4.2 Geographic distribution of the farmer clusters

The clusters are distributed evenly across the districts. In Njombe, however, farm specialists and wealthy farmers are comparatively prevalent (Figure 2.5). This can be attributed to the district's high level of collective organisation and mature dairy market. Rungwe district has a more balanced representation across the six clusters than Njombe, despite also having a comparatively dynamic dairy sector. The larger number of subsistence farmers and livestock-dependent farmers in Rungwe is foremost a product of land pressures in its more productive highland areas. This constrains household capacity to diversify into cash cropping. In contrast, the peripheral lowlands of Rungwe are dominated by more extensive dairy systems, although lack of (public) intervention in the

collective organisations and large distances from major towns and tarmacked roads inhibit commercialisation.

Figure 2.5. Farmer's typologies across the four districts

Note: High represents a dummy variable for all the high agroecological clusters across the districts (Figure 2.2), Mid represents all the mid agroecological clusters, while low represents all the low clusters in the four districts.

Marginalised entrepreneurs are comparatively prevalent in Mufindi. This reflects Mufindi's dynamic and diversified rural economy. Diverse livelihood options are available to farmers because of the prevalence of major corporations, proximity to a major national highway and relative abundance of land. Because many farmers are not reliant on dairy income, dairy markets remain poorly developed and largely informal. As expected, subsistence farmers and livestock-dependent households are comparatively prevalent in Mvomero. Some of its more arid areas are dominated by pastoral Maasai communities who keep cattle in more extensive systems. In higher elevation areas of Mvomero that are more amenable to commercial dairy, more diversified and/or dairy-oriented farmers could be observed. Based on the biophysical clusters described in Figure 2.2, subsistence farmers and marginalised entrepreneurs tend to be in low-altitude areas, while

wealthy and farm specialist households are especially prevalent in high-altitude areas. (Figure 2.5). This illustrates that even within districts, agroecological factors strongly influence socio-economic composition.

2.4.3 LED practices across clusters

This second stage of analysis examined the adoption of LED practices by cluster. Figure 2.6 shows that the uptake of LED practices varies significantly across the clusters. Wealthy and farm specialist households are most likely to employ LED practices, followed by livestock-dependent and diversified households engaged in dairy marketing (e.g., subsistence farmers and marginalised entrepreneurs). This highlights that dairy marketing and the adoption of LED practices are intimately interrelated.

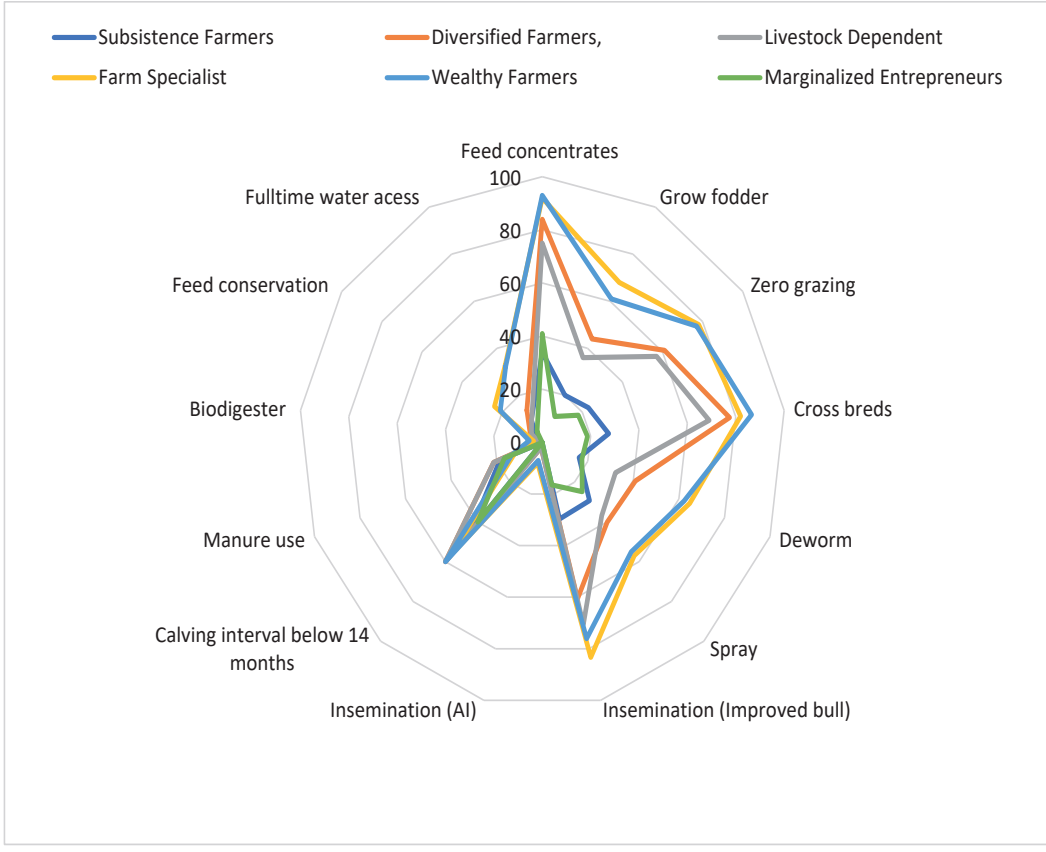

Figure 2.6. Practices across the clusters

Furthermore, results show that as farmers intensify, there is a clear preference for zero-grazing, keeping improved cows, animal health and better feeding practices (e.g., by growing improved fodder and feeding concentrates). Manure and feed management are not prioritised by any of the clusters, and neither is the use of AI, with most farmers instead opting for improved bulls. This is unsurprising because manure management does not directly affect dairy output, and AI can be expensive, difficult to access and subject to quality issues. Subsistence farmers and marginalised entrepreneurs prioritise spraying and reproductive practices, with the maximisation of herd size prioritised over dairy output. Across all the groups, practices are adopted in a similar pattern across all the clusters, primarily differing in the extent of adoption. This indicates that LED practices are typically adopted in a specific sequence, reflecting common preferences and/or constraints.

2.4.4 LED practices across the districts

Major differences in the prevalence of practices can also be observed between districts, suggesting that geographic factors also influence adoption (Figure 2.7). Farmers in Njombe are more likely to have adopted a wider array of practices, also including those on animal health and feed management. This is attributed to long-term training on feed management by development organisations and the local district extension service. For other practices, farmers in Rungwe performed on par with those in Njombe. One notable exception is manure management.

This can be attributed to comparatively small farm size and population pressures in its highland areas, with manure often used to fertilise cash crops. Rungwe also has multiple short rainy seasons, meaning farmers can apply manure on their farms more frequently compared to the other districts where rainy seasons last as long as six months. In Mufindi and Mvomero, animal health and reproduction are prioritised, reflecting the relative importance of other livestock activities over dairy due to the absence of more mature dairy markets. Less fodder cultivation in those districts also reflects the greater availability of grazing land. These findings suggest that structural constraints and conditions further mediate what practices farmers adopt. In all the districts, full-time access to water, the use of AI, feed conservation and having a biodigester scored low.

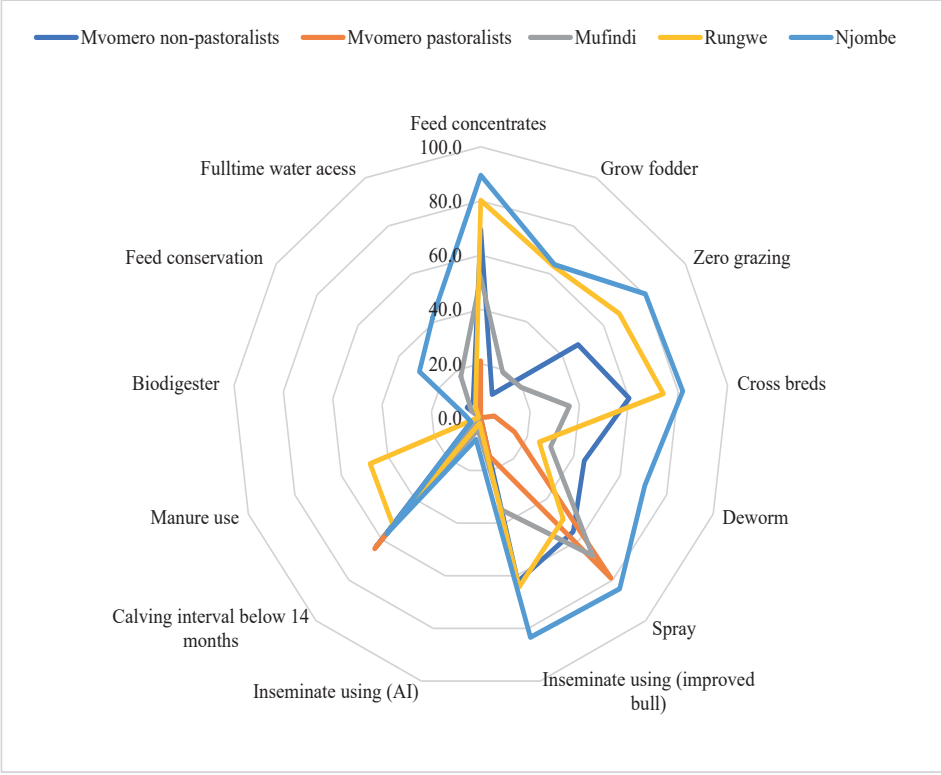

Figure 2.7. LED practices across the districts

2.4.5 Barriers to uptake of LED practices

This section presents the third stage of results on barriers to uptake of LED practices based on survey data and validation workshops. Three major barriers to the uptake of LED were identified: 1) marketing and collective action-related barriers, 2) availability of inputs, and 3) diversified livelihood objectives.

Marketing and collective action-related barriers

Households that do not sell milk did not adopt most LED practices because they have little incentive to adopt LED practices. Farmers contend that the milk market is highly volatile, with milk prices reducing during the wet season due to supply gluts. There are no standards or set guidelines within the market that explicitly incentivise the adoption of LED practices. Most farmers, irrespective of the cluster, sell milk to individual buyers rather than to processors. There are no processors in Mufindi and Mvomero that source milk directly from farmers (Figure 2.8). The farm specialists cluster has the highest percentage of respondents who sell milk to processors

(31%), followed by the wealthy cluster (27%), as shown in Figure 2.8. None of the buyers demands the uptake of LED as a pre-condition to buy milk from producers. However, producers who sell to particular processors can access personalised extension support provided by processors for free to help raise productivity, although they do need to pay for inputs.

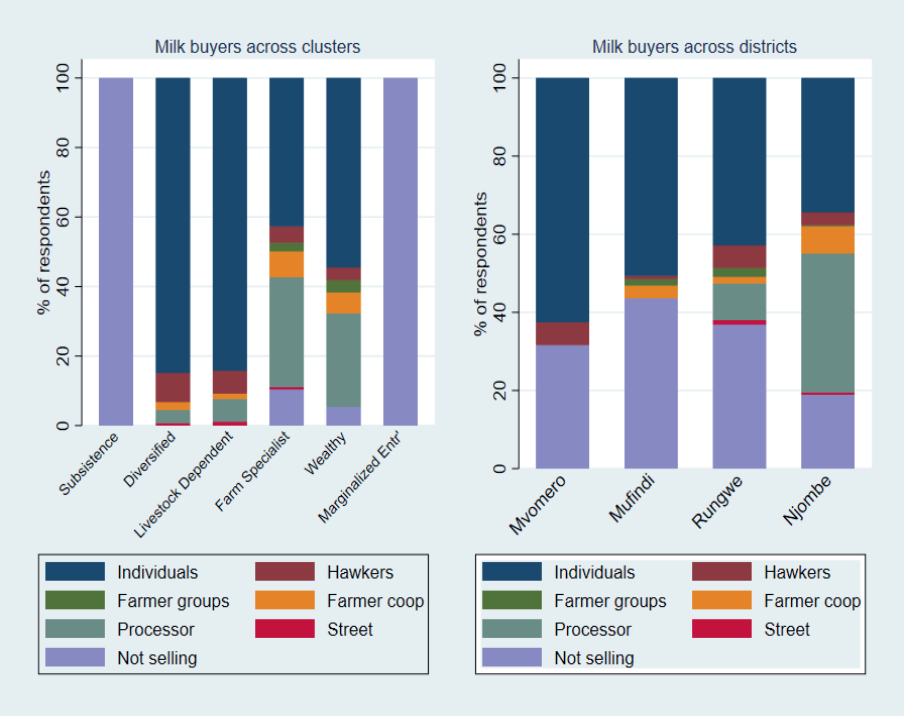

Figure 2.8. Milk buyers across clusters

Note: Marginalised Entr represents Marginalised Entrepreneurs.

As such, formal marketing (e.g., through processors and cooperatives) is systematically associated with higher overall LED performance than farmers marketing through informal channels (Table 2.6). Nevertheless, differences in performance between marketing channels do suggest that some of the LED performance is attributable to formal buyers, an interpretation supported by workshop participants. According to farmers, while it is rarely a major source of inputs, extension support provided by processors and cooperatives strengthens farmer confidence and capacity to intensify. This facilitates the adoption of certain practices, especially those that directly enhance milk yields. Manure management, however, is rarely promoted by the processor or cooperative extension service agents.

Table 2.6. LED performance by cluster and marketing channel for Rungwe and Njombe

Cluster	Not selling	Individuals	Hawkers	Cooperative	Processor	Average
Subsistence farmers	0.32					**0.32**
Diversified farmers		0.55				**0.56**
Livestock dependent		0.52			0.60	**0.53**
Farm specialists	0.53	0.57	0.62	0.65	0.69	**0.63**
Wealthy farmers		0.56		0.61	0.73	**0.63**
Marginalised entrepreneurs	0.33					**0.33**
Average	**0.35**	**0.54**	**0.60**	**0.64**	**0.69**	**0.53**

Note: the values represent a composite index score with 0 denoting the lowest adoption of LED practices and 1 highest level of adoption. Cells with n < 10 are left empty.

In Mvomero and Mufindi, between 88 and 92% of farmers sell their milk to individuals due to the absence of processors and well-developed cooperatives. LED performance for those farmers ranges from 0.32 (livestock-dependent farmers) to 0.48 (wealthy farmers), while farmers in the two clusters that do not sell at all on an average score between 0.17 and 0.18. Like in Rungwe and Njombe, those that do not sell any milk typically underperform, as would be expected, suggesting that dairy commercialisation both enables and incentivises intensification. While the non-adoption of better practices reduces the household's capacity to produce a marketable surplus, the absence of a marketable surplus also reduces the ability to adopt better practices. This represents a vicious circle that interventions should aim to disrupt through interventions that combine on-farm, technical support with the support of market institutions, such as linking technical extension services with a working marketing model, as demonstrated by private processors in Rungwe.

Poor governance of farmer organisations was also cited as a major adoption barrier. Processors pay farmers through farmer organisations rather than directly. Consequently, when group leaders are inefficient or mismanage funds, farmers encounter payment delays. This undermines farmers' capacity to plan and discourages investment in better practices. Other market-related challenges include high transportation costs and high operational costs for cooling centres.

Access to and efficient delivery of AI services was noted as problematic across all the clusters. This was evident in both the survey and workshop results. Farmers prefer to use improved bulls instead of AI because of the challenges and uncertainties associated with AI, such as poorly trained and experienced AI providers, inferior quality semen, low-success rates, high costs, lack of proper storage and transporting equipment, and large distances. This was observed across all the farmer clusters and across all the districts. Although improved bulls are widely available, there are fears

of eroding the genetic potential of the bulls and the dairy herd in general because of inbreeding and declining genetic quality. This was often mentioned in Rungwe and Njombe, in particular, where respondents noted that the productivity of their cattle breeds is deteriorating instead of improving.

Insufficient availability of pre-mixed feed concentrates is a challenge across all the sites. Farmers primarily use millers' byproducts, such as maize germ and sunflower seed cake, so they are not able to ascertain the types and amounts of nutrients provided to their animals. However, wealthy and farm specialist clusters often received training on how to mix their rations through their farmer groups. Districts like Rungwe, where cereals are not produced on a large scale, experience higher prices for the byproducts because they must be transported from other regions. This also applies to households located far from major roads and marketing centres. High feed costs are widely cited as a leading barrier to intensification.

Pluri-active livelihoods (Diversified livelihood priorities)

Farmers in the two clusters not selling milk were often unmotivated to intensify. For example, within pastoral communities, herd management is not oriented toward commercial dairy optimisation. Instead, cows produce milk for household consumption, while surplus milk is sold. And Cattle are, however mainly a measure of wealth. Acknowledging that cattle have multiple and variable functions in household livelihoods is important in understanding producers' priorities and motivations (Weiler et al., 2014). This is particularly true in locations such as Mvomero districts, which have larger herds of local cattle managed under pastoral logic.

Subsistence farmers and marginalised entrepreneurs keep more indigenous cows. They are incentivised to invest in local breeds that are managed for draft power, manure, and storage of wealth. For instance, in Mvomero, indigenous breeds are much better adapted than improved breeds to the region's harsher environments, which are characterised by poor feed quality, high temperatures and heavier disease loads. Therefore, while local breeds produce lower amounts of milk, they make substantial contributions to livelihoods in other ways, especially ones that prioritise environmental adaptiveness. The low adoption of LED dairy practices in these clusters thus appears to be associated with a separate set of livelihood priorities relating to livestock keeping.

2.5 Discussion

2.5.1 Pathways for the uptake of LED

The overarching objective of this article is to support the development of LED strategies that account for heterogeneity in farmers' capacities, priorities, and interests. Our analysis reveals six distinct farmer types with various degrees of uptake. Wealth, low TLUs and diversification of income sources were found to be defining characteristics for the wealthy and the farm specialist clusters, which also are most likely to adopt LED practices. The wealthy farmers resemble the "stepping up" category of Dorward et al. (2009). Farmers with capital and other resources at their disposal to invest in LED practices are the most obvious candidates for LED interventions involving capital-intensive practices.

The farm specialists cluster does not perfectly fit any of Dorward et al. (2009) categorisations but does resemble the "moving in" farmers of Schoneveld et al. (2019) because they are investing non-farm income into their farms. Many of these farmers were not previously cattle-keeping households but, through external assistance, have received improved cattle and training on dairy production. Households in Njombe received more support compared to other districts. This shows that long-term external investment in assets and knowledge have been key drivers of the adoption of LED practices (Liu et al., 2018). Because farmers in these two clusters are already familiar with many LED practices, upgrading is not likely to require significant technological support (Schoneveld et al., 2019). Instead, such farmers need to be sufficiently incentivised to adopt a larger variety of LED practices, including those that do not directly translate into productivity gains. This could be achieved through increased sensitisation and extension.

Because farmers in these clusters are heavily reliant on functional market demands and conditions, strategies that enhance market efficiencies, such as proper governance of farmer organisations, market standards, access to cooling centres, and access to better quality inputs, could incentivise further investment in LED. Emission reduction potential, however, is lower for this cluster. Nevertheless, emission intensities could be further reduced by enabling genetic improvements by strengthening the quality and efficiency of AI services, improving the quality of supplementary feeds, and making manure management technologies more accessible. However, a critical review of farmers' benefits within such systems needs to be periodically assessed because increased productivity can reduce milk prices, thus offsetting benefits to producers (Chavas and Nauges,

2020). This highlights that improving productivity should not be conflated with improving profitability, an important fact often overlooked in technocentric approaches to promoting LED.

Diversifying and livestock-dependent households were found to be moderately intensifying. These clusters are also moderately asset-endowed, although they have more TLUs and a greater mix of improved and local cows compared to wealthy farmers and farm specialists. Diversified farmers do not fit neatly into the categories of Dorward et al. (2009). However, they do resemble the "moving through" households of Schoneveld et al. (2019) because of their moderate and sometimes transient commitment to dairy. They are not members of farmer groups and often view livestock as an asset that can be transacted rather than as a productive resource. Interventions that would encourage such households to realise yield gains without diverting labour from other activities could incentivise the adoption of LED practices and reduce the motivation to maintain large herds. Because these producers are comparatively time-constrained, labour saving technologies, such as chaff cutters, deserve to be more actively promoted, as do those that complement other farming activities (e.g., manure management). This could be augmented with value chain development. When milk markets are not functional or too volatile, these households tend to prioritise income-generating activities that are more stable and involve fewer transaction costs. With the right mix of interventions, these farmers could contribute to significant reduction in GHG emission intensities in the short and medium term.

Subsistence farmers and marginalised entrepreneurs experience the lowest adoption rates of LED practices. They are poorly linked to markets, receive few extension services, and have little experience keeping improved cattle. The subsistence farmers resemble the "hanging in" categorisation by Dorward et al. (2009) since they are characterised by low resource endowment and vulnerability. Because these households are resource-constrained and do not sell milk, they tend not to invest in dairy intensification and receive few extension services. Interventions that address both the knowledge and resource gaps for such farmers would therefore be most appropriate. This cluster would, however, require more long-term intervention, as has been done in Njombe, involving both sustained organisational and technical training. It is also possible that these farmers might drop out of dairy farming altogether in the absence of adequate marketable surplus and reliable market access.

Interestingly, the "marginalised entrepreneurs" cluster – mostly found in Mvomero (semi-arid) and Mufindi – ranked the lowest in terms of uptake of all the LED practices, despite benefitting from alternative sources of income that could be invested into their dairy cattle. This cluster most closely resembles Dorward's "dropping out" category, meaning that they are not motivated to practice dairy commercially and thereby will be less responsive to productivity-enhancing technologies. Moving these farmers to intensive dairy production might be difficult. Dairy, nevertheless, plays a critical role in household nutritional security. Provision of livestock health services – such as control of tick-borne disease, extension services and other feed-related services, such as sustainable management and protection of grazing lands – are more in line with their livelihood priorities and will ensure increased and consistent milk supply. Innovative synergies between farming households and pastoralists could be explored, such as having farmers provide crop residues as feed for pastoral herds in exchange for depositing manure on farmers' fields. In Mvomero, pastoralists are slowly beginning to purchase or lease land for food and fodder production. This gives them an alternative source of income during the dry season but also gives them or part of their families a reason to stay in the same place. This cluster is, therefore, not a prime target for the adoption of dairy-specific LED practices. Structural and institutional issues, such as land tenure reforms and social safeguarding, would have to be resolved before LED investments are likely to be viable.

2.5.2 Linking low-emission development to agricultural transformation trajectories

The pathways approach acknowledges multiple trajectories in achieving transformation (Leach et al., 2010), illuminating the non-linear, interconnected, and complex interactions shaping outcomes (Scoones et al., 2020b; Tomich et al., 2019). For instance, the adoption of certain practices differs more between geographies than between clusters due to distinctive differences in local histories, climatic conditions, institutions, market maturity and input and service availability and accessibility. Notably, as the case of Njombe illustrates, a unique culture of collective action and strategic collaboration between development organisations and the government has played a critical role in intensifying production, promoting collaborative action, and catalysing dairy sector investment. This illustrates how future investments in the uptake of LED practices would demand both direct investment in support of farmers' uptake of LED practices and investment in coordination and alignment of multiple stakeholders' activities along the value chains and the development space.

Agroecological constraints also shape how adoption at scale can be realised. Extensive production systems involving local cattle are often more appropriate in semi-arid conditions. Even though high-altitude areas tend to demand more intensive systems, households in peripheral areas where inputs and services are less accessible and land constraints less acute are often required to adopt less intensive production systems. Despite agroecological differences within and across study districts, public interventions rarely account for geographic variabilities or discriminate against lesser-intensive production zones. In Tanzania's highlands, peripheral areas are rarely considered in government planning or are expected to transition to more intensive production systems that many cannot sustain. Dryland pastoral and agropastoral systems are too rarely prioritised because these poorly align with sectoral commercialisation and LED objectives. Even though this study only captured a small segment of farmers producing dairy within such systems, they are vitally important because such farmers account for 70% of national milk output. Raising the productivity of such farmers while maintaining their production systems can serve national food and nutritional security objectives, yet they are widely sidelined in intensification and LED discussions.

This leads us to question the operationalisation of LED as a clearly defined on-farm technological package. LED is often not positioned in the food system transformation discourse. Doing so in the future could help better account for interdependencies across production systems, ecological and cultural diversity as well as farmers' production strategies (Tomich et al., 2019). Our results suggest that research and interventions should focus more deliberately on co-creating intervention options that respond to the needs and priorities of local communities rather than focusing exclusively on technology transfers. This is especially pertinent to dryland pastoral systems that are especially vulnerable to environmental degradation and climatic shocks yet can still (moderately) intensify and become more resilient if external support is better aligned with local priorities and conditions. Our focus on (semi-)intensive dairy systems in highland environments – due to their emission reduction potential – was admittedly insufficiently calibrated to fairly analyse lowland systems. We, therefore, recommend that future research adopt more holistic food system approaches when examining LED implementation pathways. To help better embed lesser intensive/identifiable production systems in the rapidly evolving LED discourse, this ideally would involve bottom-up approaches that account for the socio-ecological conditions, livelihood strategies and cultural norms that have long inhibited systems innovation (Hebinck et al., 2018).

Failing to account for such systems in future LED strategies could deprive especially marginalised and vulnerable communities of new climate finance opportunities.

2.6 Conclusion

This article analyses the heterogeneity of smallholder dairy production systems in Tanzania in relation to LED. In doing so, we advance the literature on smallholder heterogeneity/ actor-disaggregated policy-making (Alvarez et al., 2018; Dorward et al., 2009; Tittonell et al., 2015; Schoneveld et al., 2019), as well as the literature on locally-adaptive LED (Ericksen and Crane, 2018; Herrero et al., 2016). We demonstrate the importance of designing interventions that account for both farmer socio-economic heterogeneity and structural barriers to uptake. Departing from mainstream farming systems typology approaches, this study highlights how, going forward, differentiated farmer capabilities and strategies deserve to be more explicitly accounted for when articulating sustainable and inclusive pathways. We show that wealth, off-farm income sources, cattle breeds and degree of income diversification are important sources of heterogeneity within Tanzanian dairy systems and, by extension, determinants of intensification. We furthermore demonstrate that the adoption of LED practices is simultaneously shaped by geographic, agroclimatic conditions and market conditions, and (donor) support legacies. These results illustrate that "one-size-fits-all" LED strategies are likely to result in sub-optimal outcomes, not only concerning emission reduction but also socio-economic development. Successful LED is contingent on donor and state ability to nest LED strategies within local development trajectories and priorities, as well as emergent sustainable food systems targets. The ways these different objectives and priorities articulate with each other is fundamental to understanding who LED is intended to serve.

This article points to the need to consider multiple transformation trajectories in achieving LED. First, variants of technological packages plus market-based interventions will appeal to better-resourced farmers that are more intensified and dependent on dairy incomes. While this cluster represents a potential for "quick wins", GHG reductions from targeting this cluster are likely to be modest. Because these farmers also tend to be more affluent, technologist and market-oriented LED interventions are also poorly consistent with inclusive development goals. Second, more moderately intensified households often experience more pronounced barriers to adoption, but with the right support, these are surmountable. Explicitly targeting such farmers will deliver

greater benefits with respect to GHG reductions and inclusive development. A mix of both market incentives, value chain development and concessionary access to better quality inputs and extension services could serve to catalyse the adoption of LED practices. Finally, a conceptualisation of pathways that are grounded within a food system approach rather than as a technological package would be required for households that keep more indigenous breeds and are currently not adopting many LED practices. Using a bottom-up approach that accounts for the real needs of pastoral dairy farmers would lead to more inclusive rural development, as well as enhance resilience to climate change and reduce land degradation.

The findings challenge the notion that LED is a question of a simple technological fix. We show instead that intensification, as currently conceptualised, is not equally accessible or appealing to everyone. We believe that moving beyond the technocentric approach to a food-systems approach will help LED become more synonymous with inclusive rural development. A "one-size-fits-all" promotion of LED practices would neglect a large segment of potential beneficiaries and risk falling flat or, worse, accentuating existing inequalities. An actor disaggregated intervention approach, where initiatives are tailored to fit the interests and goals of distinct kinds of farmers, has a greater chance of simultaneously achieving GHG emission reduction targets and inclusive socio-economic development.

Chapter 3

Does agricultural intensification threaten livelihood diversity? Evidence from the East African dairy sector

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3 Does agricultural intensification threaten livelihood diversity? Evidence from the East African dairy sector

Abstract

Sustainably intensifying agriculture is considered a prime pathway for reducing global greenhouse gas emissions and producing more food on existing croplands. Smallholder producers confronted by particularly large yield gaps are becoming a leading target for intervention. On paper, raising their productivity can help generate significant emission reductions per unit of production while simultaneously increasing rural output, income and food security. Evidence to support this narrative is lacking, however, with many questioning whether intensification can bring about the much-touted socio-economic benefits to make this a "win-win solution" for people and the planet. In this article, we posit that because intensification is highly labour and capital-intensive, rural livelihoods become more specialised, in turn reducing dietary diversity and capacity to accumulate wealth. Drawing on empirical research conducted in Tanzania and Kenya, we examine the relationship between intensification, livelihood diversity, nutrition diversity and wellbeing. Focusing specifically on dairy intensification, which is central to national emission and poverty reduction strategies in both countries, we find, albeit with some caveats, that dairy intensification enhances livelihood diversity, as well as nutritional diversity and wealth. These findings suggest that for certain sectors, intensification and diversification may well be complementary rather than conflicting livelihood strategies.

3.1 Introduction

The global development community increasingly prioritises the reduction of greenhouse gas (GHG) emission intensities from agriculture, with special attention to livestock production systems (Herrero et al., 2016; Uwizeye et al., 2020). At the same time, raising the productivity of smallholder farmers who continue to struggle to make a living and achieve food security through agriculture remains high on the policy agenda (Abraham and Pingali, 2020; Gomez, 2020). Low-emission development strategies (LED), generally understood as "forward-looking national development plans or strategies that encompass low-emission and/or climate-resilient economic growth" (Clapp et al., 2010: 13), are viewed as a particularly promising avenue for reconciling these two priorities.

In East Africa, LED strategies are increasingly being applied to dairy production for their purported potential to deliver win-win-win outcomes. By raising productivity through the dissemination of climate-smart production practices, national dairy output increases, emission intensities go down, and dairy farmers' incomes go up. Emission intensities are particularly high in the East African dairy sector because of poor animal feeding, manure management, herd management and animal health practices and can be addressed by strengthening public extension and building a more dynamic service sector (Ericksen and Crane, 2018). Consequently, the sector has become a prime target for delivering on both national poverty reduction and climate change mitigation targets.

While there is compelling evidence to suggest that emission intensities and productivity are typically inversely correlated (Havlík et al., 2014; Thornton and Herrero, 2010), whether LED-inspired intensification yields expected socio-economic gains is less clear. To intensify dairy may well require the household to divert land, labour, and capital from other livelihood activities, which may threaten food security and livelihood resilience. East African dairy farmers generally produce dairy within diversified crop-livestock systems with a plethora of on- and off-farm activities contributing in unique and complementary ways to livelihoods (Acosta et al., 2021). These diversification strategies allow households to spread risk and produce for both consumptive and income-generating purposes (Waha et al., 2018). While safeguarding diversification received considerable attention from the development community in the past (Macours and Premand, 2012; Megersa et al., 2014; Rider et al., 2001; Waha et al., 2018), recently, attention has been paid to

GHG emissions, and the need to intensify production may well produce unwanted externalities (see for example Tavenner et al., 2019).

By exploring the interaction between dairy intensification, livelihood diversification and household wellbeing, this article speaks to this dilemma. While intensification can be interpreted in many ways (Pretty, 2018; Pretty et al., 2011; Rockström et al., 2017), for dairy, it means producing more milk per year per cow. Intensification can lead to specialisation (Ellis and Freeman, 2005; Iiyama et al., 2008), specialisation being "…the process of concentrating resources (land, labour and capital) on producing a limited variety of goods." (Abson, 2018: 301). Diversification strategies are typically motivated by risk reduction, utilisation of idle resources and social motivations (Hansson et al., 2013; Northcote and Alonso, 2011). Because specialisation enhances farmer exposure to shocks, from a climate change adaptation perspective, diversification of crop and livestock production is generally preferred (Djurfeldt et al., 2018 in; Tavenner et al., 2019). Much research has also shown that to reduce poverty; emphasis should be placed on increasing returns to existing baskets of livelihood activities rather than encouraging households to disproportionately invest in one (Ellis and Freeman, 2005 in Iiyama et al., 2008). But, encouraging households to produce more milk per cow may well inadvertently undermine and divert resources away from other activities.

In this article, we explore whether dairy intensification drives specialisation and consequently threatens household wellbeing. We hypothesise that dairy intensification leads to livelihood specialisation, which in turn reduces dietary diversity and the ability to accumulate assets. We contend that because dairy intensification is so labour and capital-intensive, considerable household human and financial capital gets locked up by dairy, thereby necessitating specialisation. As households become more reliant on purchased inputs and the household cost burden subsequently goes up, we fear that households' ability to acquire other instrumental livelihood assets is undermined. Moreover, because on-farm feed production is also land-extensive, households may well need to produce fewer food crops, thereby threatening household dietary diversity.

To test this hypothesis, we conducted 2,250 semi-structured interviews with dairy households across seven study sites in Kenya and Tanzania. In this article, we use the data from these surveys to model the relationship between intensification and diversification and household wellbeing.

Specifically, through a multinomial treatment effect model, we estimate the effects of three levels of intensification on livelihood diversity, nutritional security, and wealth. We opted for a model that can control for endogeneity since we can assume that assignment to specific intensification regimes is non-random.

The remainder of the article is structured as follows: the next section explores existing evidence on the interplay between intensification, diversification, and wellbeing, which is followed by a more detailed description of our methods. We subsequently present the results of our analysis before discussing the implications of our findings and concluding with the article's relevance to theory and practice.

3.2 Literature review

Studies about determinants of and motivations for diversification (e.g., Alobo Loison, 2015; Ellis, 2000) and intensification (e.g., Pretty et al., 2011; Rudel, 2020) infer that concentrating productive resources on certain farm activities (e.g., specialising or intensifying), the ability to diversify declines because the productive resources cannot be utilised for other activities if the concentration on certain farm activities is to be sustained. Some posit that diversification and intensification do not take place along distinct pathways, however. Rather, rural communities can be characterised by "multiplex livelihoods" (Bryceson, 2002) and multifaceted livelihood pathways, which constitute "a complex *bricolage* or portfolio of activities" (Scoones, 2009: 172, italics in the original). This suggests that diversification and intensification are not necessarily conflicting strategies and can be mutually supportive – in contrast to early sustainable rural livelihood literature depicting these as distinct livelihood strategies (Scoones, 1998).

Most empirical research on intensification and diversification do still study these as separate strategies with distinctive motivations and determinants. They also show that higher input use – such as fertilisers, irrigation, seeds, and labour – might even encourage diversification if there are opportunities for polyculture. This applies to, for example, integrated fish and rice farming, integrated rice and fruit production (such as mango) (Rahman et al., 2016) and vegetable diversification. Research on the intensification-diversification relationship is sparse for non-polyculture systems, with evidence to support recent views on their complementary functions missing. Even though intensification features highly on many policy agendas and can,

theoretically, be risky to smallholder livelihoods, the lack of attention to the intensification-diversification interplay is concerning for praxis too.

In a similar vein, how diversification and specialisation strategies compare to their poverty alleviation potential is also unclear. A literature review of rural livelihood diversification strategies in Sub-Saharan Africa provides mixed results. For instance, suggests that due to asset constraints, most smallholders have not meaningfully benefitted from diversification (yet), but this depends on context. De Roest et al. (2018) show that diversified farms are often just as or more profitable than specialised farms, with specialisation strategies often weakening economic resilience due to excessive exposure to market volatility.

Research on the outcome of intensification paints a rosier picture, with agricultural intensification often shown to positively impact household income (Rasmussen et al., 2018). Research from Northern Ghana shows how food security can improve as a result (Yahaya et al., 2018), but the authors point to the unique conditions in this area and their findings are limited in terms of their generalisability. Research from Rwanda suggests nutritional diversity may still go down as a result of intensification (Del Prete et al., 2019). For dairy specifically, results are more mixed, with dairy intensification in Africa shown to have both positive and negative effects on income (Ahmed et al., 2000; Hoddinott et al., 2015). In a study specific to East Africa, Kebebe (2017) does find a generally positive effect of dairy intensification on both household income and nutritional diversity but shows that benefits are not evenly distributed, with marginalised producers less likely to benefit from intensification.

3.3 Materials and methods

3.3.1 Study sites

This research was conducted in Kenya and Tanzania – two countries where dairy is one of the leading agricultural sectors and contributes significantly to rural livelihoods. Across the two countries, over 80% of milk is produced by smallholders, with more than half of rural households keeping cattle. Kenya's dairy subsector contributes a sizeable 4% to Gross Domestic Product (GDP), while in Tanzania, the sector contributes 1.5% to GDP. At 110 litres per person per year, milk consumption in Kenya is among the highest in Sub-Saharan Africa. With Tanzanians on average consuming only 45 litres of milk per year, much of the Tanzanian population consumes a fraction of the recommended 200 litres per annum. Nevertheless, with milk consumption rapidly

rising in both countries and domestic demand frequently outstripping supply, long-term prospects for the sector are considered particularly favourable. Because most dairy smallholders in the region adopt low-input, low-output strategies, with better management practices, supply gaps can easily be closed.

Across the two countries, research activities were performed across seven sites, capturing a wide array of agroecological, geographic and market conditions. This includes three counties in Kenya and four districts in Tanzania (Figure 3.1). In Kenya, the study sites include Nandi, Bomet and Murang'a counties. Nandi and Bomet are both located within the former Rift Valley Province and are united under the Lake Region Economic Block. In both counties, semi-intensive systems predominate, with pockets in Nandi North and Bomet West producing more intensively. Tea is the main cash crop in both counties, but food crops such as maize, beans and potatoes are still cultivated by most households. While milk is mostly sold informally, several large processors source from these counties. In contrast, the third county, Murang'a, is dominated by more intensive dairy systems. Located in the former Central Province near the capital Nairobi, population pressure is comparatively high, and markets are more formalised. The majority of marketable milk from Murang'a is sold in Kenya's capital Nairobi. While tea is an important cash crop in the area, coffee, banana, and mango are also commonly cultivated by its smallholders.

In Tanzania, the study sites include the Mvomero district in the Morogoro region, Mufindi district in the Iringa region, Njombe district in the Njombe region and Rungwe district in the Mbeya region. In the Rungwe district, smallholders produce dairy within intensive and semi-intensive systems, alongside crops such as bananas and maize. Dairy production is highly commercialised in Rungwe, with multiple opportunities to sell through both formal and informal markets. Dairy production systems in Njombe are even more intensive because of more than 30 years of dairy development interventions. It now has a well-established farmer cooperative and a large milk processing plant. The main cash crop is tea, with some maize and potato production.

Mufindi has more semi-intensive systems but lacks a dynamic milk market. This can be partly attributed to its more crop-oriented economy in which animals primarily serve as a source of traction and crop manure. The main cash crop is maize, tea and forest plantations. Mufind also has designated grazing lands owned by the government where residents can graze their cattle. Finally, Mvomero has a wide range of dairy systems, with pastoralists keeping cows within extensive

systems and mixed crop farmers keeping their cattle under intensive or semi-intensive systems. Like Mufindi, there are no major processors collecting milk from this district.

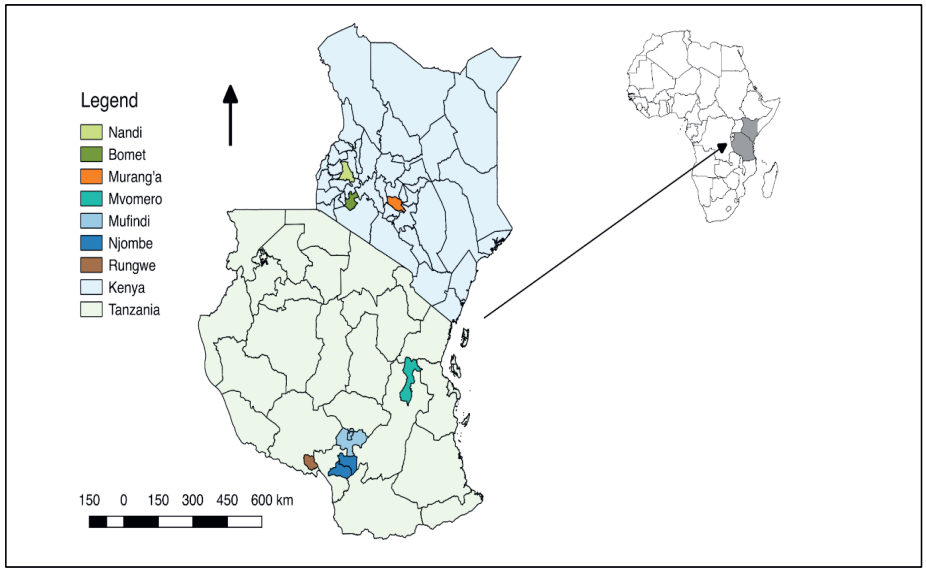

Figure 3.1. Study sites

3.3.2 Surveying activities

Data were collected from 2,250 households using a structured questionnaire. Households were sampled using a two-staged approach. First, a spatial cluster analysis was performed on each administrative unit to capture internal agroecological variabilities shaping dairy practices. Using spatially explicit rainfall, temperature and elevation data, each unit was clustered into three zones representing various levels of agroecological suitability. 36 locations were randomly selected across the three clusters in every administrative unit, with several locations per cluster proportionate to the relative size of each cluster. Villages closest to each location were selected for inclusion in our surveying activities. Households were then randomly sampled in each village based on sample frames constructed in collaboration with local authorities and leaders, with the number of farmers sampled per village informed by the relative size of each sample frame.

The administered questionnaire was loosely based on the Rural Household Multi-Indicator Survey. Topics covered in the questionnaire relate to, amongst others: (1) household demographics; (2) household assets; (3) livelihood activities; (4) dairy and crop management practices; (5) milk marketing; (6) production output, revenues, and costs; and (7) household psycho-social attributes.

Following data cleaning, 2069 households were retained for our analysis (978 in Kenya and 1091 in Tanzania). More information about the (spatial) sampling strategy and survey instrument can be found in Kihoro et al. (2021). In addition to the surveying activities, the authors also conducted validation workshops and extensive qualitative research in the study sites that support the interpretation of results (see, e.g., Kihoro et al., 2021, others are forthcoming).

3.3.3 Analytical framework

We explore the relationship between household diversification and dairy intensification and related household welfare outcomes; specifically, wealth and dietary diversity. We do that by specifying a multinomial treatment effect model using the user-written *mtreatreg* package in STATA 15 that is estimated by maximum simulated likelihood. The two-stage model estimates the effect of endogenous multinomial treatments on continuous, count and binary outcome variables. Such a model is considered appropriate for capturing multiple intensification levels while correcting for endogeneity problems. We assume that our multinomial treatment variable (intensification) is endogenous since allocation to a specific intensification regime is expected to be non-random.

In our model, the first stage consists of a multinomial selection equation that model's household allocation to one of three intensification regimes, namely intensive, semi-intensive or extensive. Regime allocation is determined by the adoption of two critical production practices: zero-grazing and the keeping of improved dairy cows (see Table 3.1). These practices are widely considered reliable predictors of overall dairy production intensity (Herrero et al., 2016).

Table 3.1. Intensification regimes

Category	Zero grazing	Improved cows	Number of observations	Proportion (%)
Intensive	1	1	885	42.77
Semi-intensive	0	1	794	38.38
Extensive	0	0	390	18.85

In the first stage, ui_{ij} represents the indirect utility function of household i for j^{th} intensification regime (j=0,1,2) and

$$ui_{ij} = x_i\alpha_j + \delta_j l_{ij} + \mu_{ij} \qquad \textit{Equation 3.1}$$

where x_i denotes exogenous co-variates with associated parameters α_j and μ_{ij}, the independent and identically distributed error terms. L_{ij} is the latent factor that incorporates unobserved

characteristics for household i treatment choice and is assumed to be independent of μ_{ij}. Let p_j represent the observable variables for the intensification regimes, then the probability of treatment can be expressed as:

$$Pr(p_j|x_i l_i) = g(x_i'\alpha_1 + \delta_1 l_{i1}, x_i'\alpha_2 + \delta_2 l_{i2}, \ \dots, x_i'\alpha_j + \delta_j l_{ij}) \qquad \textit{Equation 3.2}$$

where the vector g is assumed to follow a multinomial probability distribution with a mixed multinomial logit structure (Deb and Trivedi, 2006).

The second stage estimates the outcome equations for wealth, dietary diversity and livelihood diversification. These equations can be expressed as:

$$e(y_i|\, p_i x_i l_i) = x_i'\beta + \sum_{j=1}^{j} \gamma_j\, p_{ij} + \sum_{j=1}^{j} \lambda_j\, l_{ij} \qquad \textit{Equation 3.3}$$

where y_i denotes the welfare outcome for household i and x_i a vector of exogenous co-variates with an associated vector of parameters β, while γ_j captures the treatment effect relative to the control group (extensive dairy farmers) and λ_j the factor-loading parameter associated with the latent factors.

A total of 500 simulations were performed to estimate the model. This follows Deb and Trivedi (2006) who note that models with endogenous regressors require ten times more draws than the commonly recommended square root of n (√ 2069 = 46).

3.3.4 Variables

Outcomes were estimated using indices that proxy for livelihood diversification, nutritional diversity and wealth. Livelihood diversification is captured by the commonly used Herfindahl–Hirschman Index (HHI) (Herfindahl, 1955), a measure of income concentration. To represent diversification, we calculated an inversed HHI (*InvHHI*) as follows:

$$InvHHI_i = 1 - \sum_{j=1}^{n} s_{ij}^2 \qquad \textit{Equation 3.4}$$

where s_{ij} captures the share of total net income household i derives from income source j. Net income is derived from survey data and grouped into food crops, cash crops, livestock, dairy, forestry, formal employment, informal employment, commerce and remittances. *InvHHI* ranges from 0 to 1, with a higher value representing greater livelihood diversification.

To capture nutritional diversity, we calculated Household Dietary Diversity Scores (HDDS) following the Food and Agriculture Organisation of the United Nations (FAO, 2013). HDDS is a food consumption measure reflecting the diversity of foods households have access to and the nutritional quality of a household diets. HDDS is derived from 12 standardised questions about the types of foods consumed by the household over the last 24 hours. This includes starchy staples, dark green leafy vegetables, other vitamin-rich fruits and vegetables, other fruits and vegetables, organ meat, meat and fish, eggs, legumes nuts and seeds, and milk and milk products. Values range from 0 to 12, with higher values indicating more diverse diets.

Finally, wealth was captured using an asset index, a non-income wealth indicator. An asset index is often preferred over household income and consumption expenditure because monetary wealth indicators tend to fluctuate over time and capture only one asset from which households derive wellbeing (Kakwani and Silber, 2008; Ruggeri Laderchi et al., 2003). Asset ownership is less affected by seasonal variations and better represents long-term well-being (Rakodi, 1999). We used the approach developed by Filmer and Pritchett (2001) to calculate an asset index for each household. This involved performing a Multiple Correspondence Analysis (MCA) on binary asset variables that, based on exploratory research activities were found to be locally relevant indicators of wealth. This includes ownership of electric iron, refrigerator, mobile phone, mattress, sewing machine, stove, motorised vehicle, bicycle, DVD player, TV, radio, sofa, computer, chaffcutter, house, improved roofing material, brick or concrete wall, toilet, use of electricity and use of modern cooking fuels. Following Filmer and Pritchett (2001) the factor scores of the first component, which captures the maximum variation between households, were subsequently used as weights to construct the wealth index as forth:

$$w = f_1\left(\frac{a_1-\bar{a}_1}{s_1}\right) + f_2\left(\frac{a_2-\bar{a}_2}{s_2}\right) + \cdots f_p\left(\frac{a_p-\bar{a}_p}{s_p}\right) \qquad \textit{Equation 3.5}$$

where $f = (f_1, f_2 \ldots f_p)$ is the vector of coefficients obtained from the MCA, and $\bar{a}$ and s are the mean and standard deviation across all households for asset a_k. The wealth score for household i is then $w_i = f'x_i$, where x_i is a vector of standardised variables $(a_k - \bar{a}_k/s_k)$. Scores were then normalised (0-1), with higher values representing greater household wealth.

Descriptive statistics for the dependent and independent variables, disaggregated by treatment group, that were used to estimate our model are provided in Table 3.2.

Table 3.2. Descriptive statistics

Regime	Intensive	Semi-Intensive	Extensive	Total
Variable	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
Dependent				
Diversification	0.43 (0.22)	0.39 (0.22)	0.33 (0.47	0.39 (0.23)
Dietary diversity	7.53 (1.52)	7.14 (1.30)	6.54 (1.60)	7.19 1.50)
Wealth	0.59 (0.13)	0.51 (0.15)	0.46 (0.15)	0.53 (0.15
Independent				
Age of Household head	53.64 (12.83)	52.40 (14.09)	49.98 (13.35)	52.47 (13.48)
Male household head	0.83 (0.38)	0.83 (0.38)	0.91 (0.29)	0.84 (0.36)
Household members	5.05 (2.04)	5.71 (2.21)	6.23 (2.72)	5.52 (2.29)
Dependency ratio	0.44(0.24)	0.45 (0.23)	0.49 (0.22)	0.45 (0.24)
Indigenous to the area	0.80 (0.40)	0.84 (0.37)	0.87 (0.34)	0.83 (0.39)
Land size (in acres)	6.87 (11.06)	6.94 (10.99)	9.51 (11.32)	7.39 (11.12)
Group membership	0.57 (0.10)	0.54 (0.50)	0.20 (0.40)	0.49 (0.50)
Instruments				
Information from radio	0.11 (0.32	0.12 (0.32)	0.04 (0.21)	0.102 (0.30)
Discipline and innovativeness	0.41 (0.52)	0.25 (0.46)	0.36 (0.51)	0.34 (0.50)

Note: Values in Brackets are standard errors

To correct for endogeneity, we employed two binary instrumental variables (IV) that are assumed to be uncorrelated with the error term: use of radio to obtain technical knowledge on dairy and discipline/innovativeness of the household head. The latter indicator was derived from psycho-social questions in the survey where household heads could self-characterise themselves across seven dimensions. Only those households where heads foremost characterise themselves as being either innovative or self-disciplined were assigned a positive value (1). Based on extensive qualitative research, we feel these instruments best meet the IV relevance assumption (e.g., the IV is correlated with intensification). In all the study areas, radio is a primary source of technical information on dairy management, with innovativeness and discipline typically required to invest additional labour and capital in new practices. These IVs are expected to only affect outcomes indirectly (e.g., through intensification). Adherence to the IV monotonicity assumption is also assumed. Radio use will only have a unidirectional effect on intensification since radio broadcasts on dairy, in view of public policy, only promote intensification and are therefore unlikely to deter intensification. In view of an absence of more profitable income-generating opportunities that provide the level of prestige and co-benefits (e.g., manure for crops) in the study areas, disciplined and innovative people are unlikely to purposefully avoid dairy intensification.

3.4 Results

3.4.1 Determinants of intensification

The results of the stage one selection equation are presented in Table 3.3. As could be expected, results are generally consistent across the three models. Results demonstrate that the probability that households intensify is strongly shaped by household composition and lifecycle. Intensified households are older and smaller and have few dependents. Such households tend to have more disposable income to invest in fixed and variable inputs and hired labour, while less burdened by childcare obligations. The effects of household composition and lifecycle are less pronounced for semi-intensifying, although lower dependency ratios do appear to enable a transition away from extensive production practices.

Household origin impacts the adoption of both intensive and semi-intensive practices, with migrant (e.g., non-indigenous) households more inclined to intensify. Less constrained by "traditional" livestock management norms and with weaker access to common pool resources such as pasturelands, such households experience a greater desire and imperative to intensify. Group membership also positively influences (semi-)intensification. Because farmer groups often collectively buy inputs and sell milk, as well as facilitate horizontal learning, farmers generally gain greater confidence to adopt new practices.

Interestingly, land size positively predicts semi-intensification, but not intensification. Arguably, households with more land where cows can freely graze are less compelled to invest in zero-grazing structures, while households with less land that are necessarily reliant on feed and concentrate markets can benefit more from fully intensifying.

Finally, results also point to geographic determinants. For example, farmers in Murang'a (Kenya), Njombe (Tanzania) and Rungwe (Tanzania) are more inclined to fully intensify, compared to the base administrative unit (Mvomero, Tanzania). These districts/countries have especially well-developed milk markets, which helps reduce marketing risks and ensures surplus can be absorbed. Under such conditions, intensification risks can be more effectively ameliorated. As can be observed, farmers in Mufindi are least inclined to intensify, largely because milk markets are underdeveloped, and household milk production serves subsistence purposes. Furthermore, in the Kenyan counties of Bomet and Nandi, semi-intensification is preferred. With readily available land and pastoral commons, few farmers in these counties are incentivised to invest in zero-grazing

structures. Both IVs are statistically significant, although discipline/innovativeness is only at a 10% confidence interval.

Table 3.3. Intensification determinants

Variables	InvHHI		HDDS		Wealth index	
	Intensifying	Semi-intensifying	Intensifying	Semi-intensifying	Intensifying	Semi-intensifying
Age of household head	**0.079***	0.007	**0.083***	0.008	**0.094****	0.011
	(0.043)	(0.048)	(0.043)	(0.047)	(0.043)	(0.047)
Age squared	-0.001	0.000	-0.001	0.000	**-0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Male household head	-0.238	-0.284	-0.216	-0.253	-0.223	-0.263
	(0.278)	(0.285)	(0.279)	(0.284)	(0.284)	(0.283)
Household members	**-0.075***	-0.019	**-0.079***	-0.009	**-0.071***	-0.007
	(0.039)	(0.043)	(0.040)	(0.041)	(0.040)	(0.041)
Dependency ratio	**-0.010****	**-0.014*****	**-0.011****	**-0.015*****	**-0.011****	**-0.016*****
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Indigenous to the area	**-1.420*****	**-1.623*****	**-1.427*****	**-1.592*****	**-1.428*****	**-1.623*****
	(0.296)	(0.298)	(0.291)	(0.299)	(0.291)	(0.300)
Land size	0.001	**0.028*****	0.003	**0.029*****	0.001	**0.029*****
	(0.008)	(0.007)	(0.009)	(0.008)	(0.009)	(0.008)
Group membership	**1.607*****	**1.250*****	**1.632*****	**1.228*****	**1.526*****	**1.204*****
	(0.203)	(0.212)	(0.202)	(0.214)	(0.205)	(0.212)
Information from radio	**1.705*****	**0.798****	**1.908*****	**0.967****	**2.193*****	**0.866***
	(0.374)	(0.377)	(0.391)	(0.421)	(0.384)	(0.484)
Discipline/ innovativeness	**0.325***	**0.267***	**0.290***	**0.372***	**0.331***	**0.372***
	(0.177)	(0.187)	(0.178)	(0.198)	(0.176)	(0.198)
Mufindi	**-1.276*****	0.284	**-1.149*****	0.286	**-1.144*****	0.311
	(0.321)	(0.329)	(0.316)	(0.321)	(0.315)	(0.321)
Rungwe	**2.925*****	**1.886*****	**2.996*****	**1.868*****	**2.958*****	**1.882*****
	(0.314)	(0.366)	(0.314)	(0.373)	(0.309)	(0.374)
Njombe	**2.465*****	0.341	**2.509*****	0.307	**2.622*****	0.398
	(0.297)	(0.396)	(0.296)	(0.410)	(0.296)	(0.402)
Bomet	0.027	**5.515*****	0.042	**5.513*****	0.102	**5.540*****
	(0.485)	(0.405)	(0.494)	(0.406)	(0.498)	(0.412)
Nandi	**-1.032***	**4.996*****	**-1.084***	**4.992*****	**-1.013***	**5.019*****
	(0.547)	(0.397)	(0.556)	(0.401)	(0.563)	(0.410)
Murang'a	**3.259*****	**1.196*****	**3.314*****	**1.081****	**3.311*****	**1.128****
	(0.374)	(0.461)	(0.370)	(0.464)	(0.369)	(0.469)
Constant	-1.544	-0.763	-1.683	-0.930	**-2.012***	-0.991
	(1.160)	(1.366)	(1.177)	(1.314)	(1.167)	(1.321)

Note: The base category is the extensive producers. * = p < 0.10, ** = p < 0.05, *** = p < 0.01. Values in Brackets are standard errors

3.4.2 Effects of intensification

The second stage of our model estimates the effect of participation in different intensification regimes on the three outcome variables (Table 3.4). The results largely show significant positive effects of intensification across all three outcomes, especially for intensified households. Discrediting much of our hypothesis, our results show that households within the intensification regime become more diversified and achieve greater dietary diversity and wealth. While households in the semi-intensification regime also achieve greater dietary diversity and wealth, albeit not to the same extent as intensified households, their livelihoods do appear to become more specialised. As can be observed, across the three models, effects are positively moderated by the household heads being male (as opposed to female) and the amount of land owned, but negatively by dependency ratios (e.g., fewer dependents contribute positively to our outcomes).

For the intensification regime, the factor loadings for the latent factors *(λ intensive)* are statistically significant and negative in all three models. As proxies for unobserved covariates, this implies that unobserved factors that increase the likelihood of intensification reduce the outcome effect compared to random selection. In other words, treatment and outcome are negatively correlated through unobservable factors, with households with below-average wealth and livelihoods and nutritional diversity being more likely to intensify. Because we observed negative selection without correcting for the non-random nature of intensification decisions, our results would have been downward-biased. In the case of semi-intensified households (*λ semi-intensive)*, negative selection is also observed in relation to nutritional diversity, although no correlation can be established between wealth and treatment. In contrast, the significant positive effect of the factor loading on diversification points to positive selection and risk of upward-bias results for semi-intensified households without correction.

To better illustrate effect size, we calculate the predicted value by the country for each model at means (e.g., co-variates are held constant). This shows that a transition from extensive dairy production to intensive dairy production increases dietary diversity, livelihood diversity and wealth by 22%, 44% and 50%, respectively (Figure 3.2). By comparison, transitioning to semi-intensify systems increases dietary diversity by 15% and wealth by 19%, but reduces livelihood diversity by 29%. Differences in effect size between the two countries are nominal.

Table 3.4. Intensification impacts

Variables	InvHHI	HDDS	Wealth index
Intensive	**0.158*** **	**1.399*** **	**0.231*** **
	(0.022)	(0.169)	(0.01)
Semi-intensive	**-0.074*** **	**0.937*** **	**0.045*** **
	(0.022)	(0.222)	(0.02)
Age of household head	0.001	0.012	**0.003** **
	(0.003)	(0.016)	(0.001)
Age squared	-0.000	-0.000	**-0.000** **
	(0.000)	(0.000)	(0.000)
Male household head	**0.032***	**0.181** **	**0.031*** **
	(0.017)	(0.083)	(0.009)
Household members	0.003	0.010	**0.005*** **
	(0.003)	(0.015)	(0.002)
Dependency ratio	**-0.000***	**-0.003***	**-0.001*** **
	(0.000)	(0.001)	(0.000)
Indigenous to the area	0.015	**-0.188** **	**-0.029*** **
	(0.016)	(0.091)	(0.009)
Land size	**0.002*** **	**0.012*** **	**0.002*** **
	(0.000)	(0.004)	(0.000)
Group membership	**0.037*** **	-0.085	0.003
	(0.011)	(0.068)	(0.006)
Mufindi	**0.072** **	**1.038*** **	**0.125*** **
	(0.033)	(0.155)	(0.014)
Rungwe	-0.023	**0.407** **	**-0.035** **
	(0.022)	(0.166)	(0.015)
Njombe	-0.001	**0.485*** **	0.018
	(0.024)	(0.163)	(0.016)
Bomet	**0.095*** **	**0.532** **	0.027
	(0.026)	(0.216)	(0.028)
Nandi	**0.129*** **	**0.562*** **	**0.065** **
	(0.031)	(0.213)	(0.028)
Murang'a	**-0.070** **	**0.702*** **	**0.062*** **
	(0.028)	(0.169)	(0.017)
Constant	**0.217*** **	**5.484*** **	**0.276*** **
	(0.075)	(0.475)	(0.042)
lnsigma	**-3.052*** **	**0.205** **	**-2.441*** **
	(0.665)	(0.098)	(0.172)
λ intensive	**-0.065*** **	**-0.580*** **	**-0.098*** **
	(0.015)	(0.137)	(0.018)
λ semi-intensive	**0.215*** **	**-0.453** **	-0.018
	(0.013)	(0.203)	(0.024)
Sigma	0.01	1.23	0.04
	(-0.01)	(-0.06)	(-0.01)
LR test Chi^2 (2)	**43.09*** **	**5.74***	**13.26*** **
N	2,048	2,069	2,069

Note: LR= test of independence of equation. The base category is the extensive producers. * = $p < 0.10$, ** = $p < 0.05$, *** = $p < 0.01$.

The likelihood-ratio test for exogeneity of treatment is positive and significant across the three models. This implies that the null hypothesis of exogeneity is rejected at a 1% level of significance for the diversification and wealth models, but only at 10% for the dietary diversity model. This confirms the presence of selection bias and the necessity of correcting this.

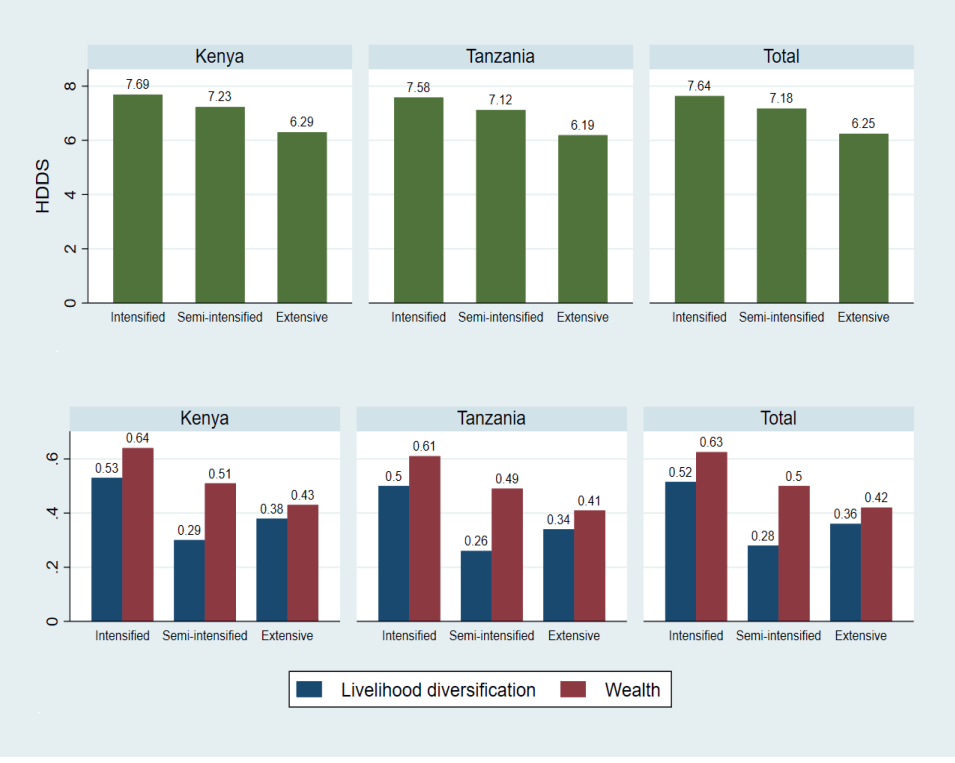

Figure 3.2. Average predicted values per country and production system

3.5 Discussion

This article examined the relationship between dairy intensification and livelihood diversification and household wellbeing in East Africa. We hypothesised that dairy intensification leads to livelihood specialisation and reduced livelihood diversification, which then undermines household nutritional diversity and the ability to accumulate wealth. Our results largely reject this hypothesis by suggesting that households adopting more intensive dairy systems become more diversified and manage to achieve greater dietary diversity and wealth than a household with more extensive systems. These results lend credence to the "win-win-win" discourse prevalent in both scholarship and policy (Herrero et al., 2016; Uwizeye et al., 2020). Reduced emission intensities that

intensification promises to deliver can likely be achieved while simultaneously safeguarding agrobiodiversity and mixed cropping systems and advancing (the resilience of) rural livelihoods. At the same time, our results suggest that, contrary to early sustainable livelihoods literature (Scoones, 1998), intensification and diversification are not distinct livelihood strategies but may well be complementary and mutually reinforcing strategies in certain contexts.

Based on extensive qualitative research and validation workshops with respondents, more intensive dairy farmers are motivated to pursue diversified livelihoods foremost because of the synergistic effects between cropping and livestock keeping. For example, the use of maize stovers as feed and the use of dung as manure allows households to recycle nutrients more effectively. This is consistent with observations from Acosta et al. (2021). Additionally, we also observe that diversification is purposefully pursued by intensive households to ensure additional sources of income are available to finance dairy inputs (e.g., during times when milk prices are low, cows die, or input prices escalate due to shortages). In a similar vein, with dairy considered a comparatively high-risk activity, many households try to avoid excessive dependence on dairy income and rather reinvest dairy proceeds into other income-generating activities. We do however find that semi-intensive households are less diversified than extensive and intensive farmers. We argue that resource diversions do take place, at least initially, with households required to (temporarily) reduce resource allocations to other livelihood activities, as they intensify dairy. Acquiring and keeping improved cows requires significant human and financial investment and the need to save for zero grazing structures likely further contributes to this. Once farmers can start consolidating their household income when they manage to become fully intensified, surpluses can be more effectively reinvested in other activities.

However, this reasoning likely applies to a sub-sample since in some of our study areas where land is relatively abundant many semi-intensive dairy farmers have no ambition to further intensify. This is despite semi-intensive households having the least diverse livelihood portfolios, and thereby can be considered the most specialised in dairy: dairy plays a central role in their livelihoods. Not wishing to further intensify can be because they have more land and can allow their cattle to graze, which is considered financially more interesting than having to invest in buying feed. This thereby also warrants against assuming that households always wish to intensify or that intensification is a binary: to intensify or not to intensify. Qualitative research disclosed

that some households temporarily employ practices associated with dairy intensification in certain periods of the year. Understanding processes of combinations of livelihood strategies such as intensification and diversification over time is essential for further sense-making of our findings.

With findings showing that households with dairy-intensive systems have greater household dietary diversity and wealth, there is reason to assume that diversification somehow contributed to this. Qualitative research revealed that more regular (almost daily) income associated with intensification-induced productivity gains allows households to plan their finances, asset investments and food purchases better. This explains why dairy intensification, ceteris paribus, directly improves household well-being. However, indirectly, being able to manage manure more effectively because of zero grazing contributes to greater productivity and reduced input acquisition costs for cropping activities. Similarly, having a more regular income allows households to reinvest more income in a timelier manner into other activities, which in turn increases net economic surplus. In other words, dairy intensification contributes both directly and indirectly to household welfare. Our modelling approach is not equipped to measure the magnitude of the indirect (e.g., diversification-induced) effects, however. This, as well as the precise mechanics, could be an interesting area for future inquiry.

In addition to not being able to capture the magnitude of indirect effects, our study also does not speak about the effects of intensification on intra-household costs and benefit distribution patterns. Even though intensified households on average have more diverse diets and can accumulate more wealth, this does not mean that, for example, women in the household are necessarily better off. Keeping improved cattle is labour-intensive (Lenjiso, 2020; Paul et al., 2021). In our research areas, women play an important role in milking, cleaning, feeding and marketing (Tavenner and Crane, 2018), which could imply that the female labour burden might also have increased disproportionately (Tavenner et al., 2019). Similarly, our modelling approach captures only aggregate effects and not distribution patterns within groups. As the findings from Kihoro et al. (2021) illustrate, not all (intensive) producers are the same, meaning that some undoubtedly benefit from intensification more than others. With our findings suggesting that farmers with more land (that are probably more affluent) achieve better outcomes, intensification could produce some inclusivity challenges.

Furthermore, our HDDS measure has limitations: nutritional diversity does not mean households are necessary food secure throughout the year or necessarily meet their calorific and nutritional requirements. While the correlation between HDDS and other measures of food security is considered strong (Leroy et al., 2015), we urge future research to consider other dimensions and indicators of food security. As such, while our research shows that intensification has the potential to produce win-win-win outcomes, limitations do suggest that some caution is warranted. Further research into particularly intra-household effects and impact heterogeneity issues, including related to conditions under which households take decisions, is needed to arrive at more definitive conclusions.

Policy implications

For policy targeting and LED design purposes, we do urge that the wider production systems in which dairy production is to be intensified are more explicitly considered, particularly for most smallholders that are currently practising semi-intensive and extensive dairy farming. This can, for example, be done by targeting systems where crops whose residues can function as (sufficiently nutritious) animal feed and where soils stand to particularly benefit from organic amendments or by helping farmers that aspire to intensify dairy to fully exploit synergistic potentials. This requires geographically grounded approaches that account specifically for the pluri-active nature of rural livelihoods in low and middle-income countries.

We expect our results to be relevant to low and middle-income countries, where rural dairy-producing communities are typically accustomed to crop-livestock integration. However, in countries where commercial dairy markets are less developed, increasing milk production without having the markets needed to absorb more milk may instead produce greater milk losses and reduce farmers' ability to recover incurred costs. In such contexts, sector commercialisation objectives need to feature explicitly in intensification strategies and associated policies. However, although some of the semi-intensive households have the resources to intensify, it might not make financial sense, or they prefer to prioritise other livelihood activities.

With intensification also featuring in climate and poverty alleviation policy discourse for a wide diversity of agricultural activities, whether a virtuous relationship between intensification and diversification can be observed outside dairy (and how that can be maximised) is supremely relevant to increasing food production within planetary boundaries, while also safeguarding the

environmental services generated through diversified (agroecological) smallholder production systems.

3.6 Conclusion

Sustainable development policy is increasingly concerned with sustainable agricultural intensification. Livestock in general and dairy, in particular, receive attention for their comparatively high and fairly reducible GHG emissions in East Africa via LED. Achieving meaningful reductions in emission intensities demands greater intensification. In this article, we explored whether intensification is necessarily pro-poor, as policymakers claim and as LED assumes. With intensification potentially requiring livelihood specialisation as household land, labour and capital resources are diverted from other livelihood activities; we feared that household well-being might be adversely impacted.

Our results do not support our fears. Rather, they show that more intensified households on aggregate are more diversified, better able to accumulate livelihood assets and have more diverse diets. Albeit with caveats, these results partly legitimise recent enviro-centric policy and LED innovations focused on intensifying dairy and suggest that "win-win-win" can be achieved under certain conditions for certain households. We do, however, find that semi-intensive households are less diversified than extensive and intensive farmers.

In addition, to the policy relevance of this article, this research also contributes to closing an important gap in scholarship relevant to agricultural development and sustainable rural livelihoods in general, namely the relationship between intensification and livelihood diversity. By showing that these are unlikely to be distinct strategies and are complexly related and potentially additive, our results give reason to devote more attention to this relationship in dairy and other sectors.

Chapter 4

Marrying low emission development and local business systems: evaluating sub-national realities in the Tanzania dairy sector

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4 Marrying low emission development and local business systems: evaluating sub-national realities in the Tanzania dairy sector

Abstract

Low-emission Development (LED) in agriculture is often driven by global strategies. While national-level policies try to align with global policy discourse, local development interests and needs do not always align with national LED initiatives. The dominant narrative in achieving LED within the livestock and dairy sector entails intensification and commercialisation, as improved practices on the farm increase productivity, reduce emission intensities and integrate the market to ensure that surplus produce is marketed. This LED narrative is plausibly exclusionary since vulnerable groups, production systems and even regions that are not amenable to intensification and commercialisation risk being side-lined. Additionally, there is potential for misalignment of LED with divergent social, economic and institutional dimensions. This paper argues that the efficacy of LED is conditioned by diverse agroecological realities, local business and governance environments. We employ Business Systems Theory to cross-examine variability across spatially bounded business systems and its implication for LED. Qualitative data collection methods were used to evaluate dairy development priorities and practices across four districts in Tanzania. Our results show that business systems that feature more informal actors are less amenable to mainstream intensification and commercialisation approaches. Pushing such systems into a formalised commercialisation pathway plausibly disrupts existing functional economic networks. This study also advances the BST literature by extending it to sub-national analysis within the agrarian sector. Using the business systems perspective opens space to start from a grounded diagnostic of what local contexts are capable of before imposing a generic LED pathway.

4.1 Introduction

Globally, there is an increasing impetus for action toward LED in the agriculture sector (Buseth, 2017). With most developing countries signatories to the 2016 Paris Agreement, financial and technical assistance to design and implement emission reduction policies is becoming more readily accessible (United Nations, 2015). Many developing countries' policies emanating from global agreements prioritise agricultural emissions, particularly from the livestock sector (Newell and Taylor, 2018), because sustainable livestock intensification is seen as an engine for rural development where reduced environmental footprint can be a co-benefit. LED seeks to reduce greenhouse gas (GHG) emissions, increase productivity and support economic development in a "coherent and strategic way" (OECD-IEA, 2010, p. 6), with LED strategies outlining governmental plans to deliver on emissions reduction targets. Despite multi-faceted aspirations, measures of LED success continue to focus on technological fixes for reducing GHG emission intensities or on GHG monitoring, reporting and verification (Majule et al., 2014; Yocum, 2016).

This dominant technocentric perspective does not systematically account for LED's social, economic and institutional dimensions, which are important considerations for how technical solutions become socially situated (Crane et al., 2021). Therefore, the potential (mis)alignment of LED with social or development policy remains insufficiently problematised and under-researched. A narrative that risks side-lining marginal groups, production systems and even regions that are not amenable to standard approaches of intensification and commercialisation. The technocentric conceptualisation of LED also tends to gloss over diversity, both in terms of inter-household and intra-household distributional outcomes (Kihoro et al., 2021; Tavenner et al., 2019; Tavenner and Crane, 2019). This study shifts focus from farming household categories (see Kihoro et al., 2021) to sub-national economic configurations (Baud et al., 2002) in which diverse actors' capacities and resources combine and shape the conditions for realising LED.

The tandem of intensification and commercialisation is central to many agricultural LED strategies (Van der Lee et al., 2018), particularly in livestock sectors (Havlík et al., 2014; Herrero et al., 2016). Such a narrow technocentric conceptualisation of LED has implications for what solutions are promoted and which actors or areas are slated to benefit (Newell and Taylor, 2018). From this perspective on LED, intensification is conceptualised as technological practices that increases productivity and resource use efficiency (Clay et al., 2020), which in turn reduces GHG emission

intensities (Ericksen and Crane, 2018). Commercialisation is generally seen as incentivising the adoption of intensification technologies and thereby assumed to be conducive to LED. Moreover, these strategies implicitly assume that intensification and market incentives will automatically translate into socio-economic gains and will have beneficial outcomes across all actors (Clapp et al., 2010; De Pinto et al., 2014). This paper takes the multiplicity of development pathways emerging in sub-national business environments as the starting point for exploring the conditions under which LED strategies may have material consequences on the ground.

Drawing on empirical data on dairy production networks in four districts in Tanzania, this study examines how the efficacy of LED is conditioned not only by diverse agroecological realities but also by local business and governance environments. Tanzania has a large cattle population, denoting the potential to leverage reduction in GHG emission intensity from the sector. However, failure to account for sub-national diversity risks leading to inappropriate intervention designs and undesirable outcomes. Within the Tanzanian dairy sector, the diversity of district-level institutional aspects ranges from cultural norms to state-business relationships to local bureaucracies and administrative traditions (Hydén, 2016; Schouten et al., 2018).

We use business systems theory (BST) to analyse the complex relationships between local institutions with clear implications for implementing LED strategies (Hotho, 2014; Whitley, 2007). LED policies and interventions are often based on the assumption of certain kinds of business systems with a regulatory state, and economic activity is mainly driven by well-established firms, with well-designed and layered capitalistic structures (Sadler et al., 2016; WBCSD, 2020). For LED strategies to have material consequences on the ground, it is essential to understand how coordination and control within and between major groups of economic actors are organised and managed. Additionally, an assessment of how the roles and actions of the state affect business, and how those interactions, in turn, shape smallholders' capabilities and organisational structures conducive to intensification and commercialisation is paramount. This would enable LED to leverage existing relations more effectively between businesses, government and smallholders (Dulal et al., 2011).

BST adopts a historical and regional perspective on how the relations between main economic actors and the state evolve (Whitley, 2007, 1999). It acknowledges that different place-based societal domains interact to create distinct forms of economic organisations (Whitley, 1999). By

typifying spatially bounded business systems, our unit of analysis, we develop a systematic and theoretically grounded approach for characterising economic diversity. This gives us a foundation for assessing how LED strategies can be designed to respond to business systems diversity. Even though BST was originally conceived to capture business systems diversity in industrialised sectors, its main objective is to evaluate distinctive and cohesive business systems, which could be reproduced at different geographical levels. We repurpose the framework by applying it at a sub-national level within the agricultural sector in a developing country. In doing so, we offer conceptual innovations into novel applications of BST, in addition to insights into the empirical case.

This paper proceeds as follows: we begin by outlining the key features of BST. Second, we review the dominant narrative on GHG mitigation and dairy development in Tanzania. We then present the results. Here, we critically examine the alignment between dominant global and national LED narratives on intensification and commercialisation with sub-national business system realities. We conclude with a reflection on the practical and theoretical relevance of the findings.

4.2 Analytical framework

4.2.1 Diagnosing local diversity with a business systems lens

The premise behind BST is that interactions between firms and institutionalised norms shape what types of firms, priorities, strategies and linkages develop within specific geographies (Whitley, 1999). BST analyses how interactions between firms and social institutions result in "societally distinct modes of coordinating economic action" (Redding, 2005, p.11; Whitley, 2007, 1999). Actors involved in shaping business systems include business owners, employees, experts, managers, state officials and unions (Allen, 2014). The relationship between these actors is contingent on the institutions that structure them (Allen, 2014; Whitley, 1999). Within the dairy sector, these actors and institutional conditions are important in shaping both process and channel of development. For example, commercialisation is dependent on market opportunities and support structures and intensification on input and service accessibility, terms and use norms. By centring the structures that condition behaviour, BST offers a more institutionalist perspective than most prevailing technocentric approaches.

Generally, business systems are characterised by: (i) the *role of the state and the state-business relations*, and (ii) the *nature of doing business* (Helmsing and Vellema, 2011a; Whitley, 1999).

Each business system dimension in turn consists of several different parameters and indicators. These can be summarised as follows:(i) *Role of state and state-business relationship*

The state defines and enforces private property rights, maintains public order by enforcing rules and regulations, regulates public financial systems, and shapes labour and skills development (Whitley, 1999). It focuses on the role of the state within business systems, which can involve direct participation or facilitatory and regulatory functions (Helmsing and Vellema, 2011b; Whitley, 2007). Whitley (2007) describes four types of state roles: (a) *arm's length*, where the state is not engaged in the economy; (b) *dominant developmental*, where the state is heavily engaged in the economy resulting in limited scope for non-state actors; (c) *business corporatist*, where the state closely collaborates with and supports companies and their partners; and (d) *inclusive corporatist*, where the state expands this collaboration to include other important actors such as labour unions (Whitley, 2007, 1999).

The "extent of formal regulation of markets and state antagonism to collective intermediaries" (Whitley, 1999, p. 48) is integral to understanding state-business relationships. Business corporatist states, for example, are often closely allied to corporate lobby groups, favouring deregulation, and inhibiting collective bargaining movements. They can also support and give direction to business systems development by facilitating and enabling (certain) economic activities. From an inclusive development perspective, this could involve regulations that level the playing field, facilitate new entrants, reduce business risks or facilitate collective organisation and coordination (Mitchell and Coles, 2011). For our purposes, we follow Whitley (1999) in focussing on the nature and extent of state involvement in the dairy sector, as well as the level of regulatory enforcement and support to collective intermediaries (Table 4.1).

Table 4.1. Key characteristics of business systems

Indicators	Description	Levels
Role of state and state business Relationships		
The dominance of the state in the economy	The extent to which the state dominates the economy and shares risks such that business becomes dependent on the policies and actions of the state	Low= minimal state involvement in the economy Moderate= considerable state engagement in the economy High= state as an economic actor in the dairy sector
State relationship with collective intermediaries (e.g., farmer cooperatives)	The extent to which the state encourages the establishment of important intermediary economic socialisation between individuals or firms.	Low= state not encouraging collective intermediaries Moderate= state partly encourages collective intermediaries High= state helps in facilitating collective intermediaries (e.g., through training)
The extent of formal regulation of markets	The extent to which the state directly or indirectly regulates market boundaries.	Low= state has minimal regulation enforcement. Moderate= the state moderately enforces regulation (e.g., minimal taxes and inspection is not as often) High= state enforces high regulation with frequent visits to ensure compliance
Ownership coordination (Nature of ownership)		
Primary means of owner control (direct, alliance, market contracting)	This denotes the primary ownership arrangements across the business system	i) Direct control of firms by owners, ii) alliance control owners delegate considerable decision-making to managers but remain committed to firms, iii) market or arm's length control (e.g., portfolio holders in capital markets)
The extent of ownership integration of production chains	Denotes **vertical integration** across different nodes in the value chains. (e.g., processing farms engaging in other activities, e.g., production or retail)	Low= integration denotes no vertical integration of producers and suppliers High= high vertical integration
The extent of ownership integration of sectors	Denotes **horizontal integration** across sectors, for instance, processing plants engaging in different product lines (e.g., fresh milk, yoghurt)	Low= minimal integration with other competitors Moderate= minimal or selective integration (e.g., across seasons) High= high collaboration among other competitors
Non-ownership coordination (inter-firm connections)		
Extent of alliance coordination of production chains	Integration of activities through alliances, obligations and other non-ownership linkages between members of a production chain	Low= minimal integration with non-ownership integration (e.g., other stakeholders within the production chain) Moderate= conditional integration (e.g., across selected activities or time periods_ High= high level of coordination across activities

Indicators	Description	Levels
Extent of collaboration between competitors	Relationship between competitors (collaboration or competitive)	Low= denotes high competition while. High= denotes collaboration among competitors
Extent of alliance coordination of sectors	Alliances between firms in different sectors	Low= minimal integration with other sectors (e.g., funding organisations and other sectors) Moderate= relative degree of integration with other organisations High= strong integration with other sectors
Employment relations and work management		
Employer-employee interdependence	This denotes whether employers rely on external labour in managing the bulk of the work or invest in organisational capabilities	Low= minimal reliance on employees. Moderate= selective reliance on employees (e.g., on only certain roles) High= full reliance on employees and delegation of roles
Delegation to and trust of an employee	Discretion and trust employees grant to the bulk of the workforce in organising and carrying out tasks	Low = minimal trust in employees Moderate= moderate trust in employees High= full trust in employees in organising work

Source: Adapted from (Hotho, 2014; Whitley, 1999).

(ii) *Nature of doing business.*

To examine how businesses do business, BST combines relational and political-economic perspectives (Andriesse et al., 2011) to emphasise chain governance structures and competitive dynamics. This concretely consists of *ownership coordination* (nature of ownership), *non-ownership coordination* (inter-firm connections), and *employment relations* (See Table 4.1). Ownership coordination defines the relationship between business owners and business controllers. Whitley (1999) distinguishes between three types of ownership (a) *direct control,* where business owners have direct control in business management and decisions; (b) *alliance control*, where most of the decisions are delegated to managers; and (c) *market or arm's length control,* where business owners have a distant relationship with business management and daily operations. Non-ownership coordination focuses on vertical and horizontal coordination between businesses or firms shaping economic activities. Horizontal coordination is the process where firms or individual actors coordinate within a functional node in the value chain, while vertical coordination spans across different nodes in the value chain, products or market-specific services (Coles and Mitchell, 2011). Employment relations and work management denote the levels of trust and delegation the employer gives to employees. Table 4.3 below shows the various business systems dimensions.

4.2.2 Tailoring BST to the dairy sector in Tanzania

Although most BST research focuses on differences across countries (Rana-Mohammad Bakhtiar and Morgan-Glenn, 2015; Hotho, 2014; Redding, 2005; Whitley, 1999), we innovate on the framework in two major ways. Firstly, we apply it within a country to analyse differences across districts. As stated by Whitley "… distinctive systems of economic organisation arise wherever key associated institutions are both mutually reinforcing and distinctive" (Whitley, 1999, p. 44). Whitley further explains that "distinctive and cohesive kinds of business systems can become established and reproduced at regional, national and international levels of socio-economic organisation depending on the strength and integration of actors and institutions involved at each level" (Whitley, 1999, p. 46). (Frumence et al., 2013). In addition, other studies focusing on BST studies emphasise the need to be guided by empirical analysis in defining spatial borders in business systems (Andriesse et al., 2012; Schaumburg-Muller, 2001). This is especially important in developing countries where business systems are highly fragmented; the decision to use either national or sub-national regions as a unit of analysis should be guided by the homogeneity in cultural and institutional arrangements in the study area (Andriesse et al., 2012; Jakobsen and Torp, 2001; Schaumburg-Muller, 2001). Tanzania is governed through decentralisation by a devolution strategy, in which Local Government Authorities are largely autonomous institutions with decentralised powers, functions and authority. Economic activities and types of business vary across the LGAs, with diverse actors, levels of coordination and state control. All the selected districts in this study are within different LGAs. Furthermore, because many economic actors in developing countries (especially the small and medium enterprises) lack national reach, comprehensively capturing business systems diversity in such contexts demands a sub-national focus (Andriesse et al., 2012). Those sub-national economic actors fundamental to facilitating market access in rural areas risk being rendered invisible by a perspective that focuses only on national-level lead firms.

Secondly, we apply the framework within the agriculture sector, specifically dairy. To capture BST characteristics relevant to the agrarian change in developing countries and LED, commercialisation and intensification are incorporated as key indicators in capturing inter-regional diversities (See Table 4.2). Commercialisation is defined as the act of sourcing milk from farmers and selling it to consumers. Our definition of commercialisation, therefore, captures all actors within the value chain including lead firms, other traders in milk selling, and mediating actors

(e.g., NGOs shaping milk marketing strategies). In doing so, we assess the presence of a lead firm in each district, non-lead actors and the role of NGOs or donor organisations mediating economic organisations within the dairy sector. For this study, we define a lead firm as a large or medium processor/trader collecting milk from farmers with a large enough market share (in terms of volumes of milk collected in a district) to influence milk demand among milk buyers/traders and prices. "The lead firm has substantial power, enabling it to include or exclude actors or to arrange access to resources" (Helmsing and Vellema, 2011b, p. 15). We also explicitly analyse the formal regulations and informal rules (e.g., lack of written, formal agreements between milk suppliers and buyers) that mediate coordination. This innovation in BST help makes it a better fit for developing countries while maintaining the BST concepts at an abstract level.

Table 4.2. Cross-cutting aspects of LED within BS

Indicators	Description	Levels
Commercialisation		
Integration of smallholder farmers into milk markets	Types of actors mediating milk marketing in the district	1= presence of a lead firm 2= mix of lead firm and other actors 3= role of NGOs and donor organisations in shaping milk markets
Integration of the regional livestock sector into the national economy.	The extent to which the sector is integrated into the national economy (e.g., supplying milk to other parts of the country).	1= integrated into the national economy 2= local economy with no integration with the national economy
Intensification		
Dominant production system	The dominant mode of production in the district (e.g., mainly zero-grazing denoting, intensive production systems, or extensive systems, e.g., pastoral systems)	1= intensive systems 2= semi-intensive systems 3= extensive systems
Uptake of intensification practices and provision of inputs and services	The average uptake of production dairy practices in the district includes improved feeding practices, animal health and manure management practices.	1= low uptake of intensification practices 2= moderate uptake of LED practices 3= high uptake of intensification practices

Source: Own conceptualisation

Intensification is operationalised through a dominant production system (intensive, semi-intensive and extensive) and the level of uptake of low-emission dairy practices (improved feeding, animal

health/husbandry and manure management practices). In applying this framework to specific sub-national sectoral systems, not all indicators are equally relevant or able to fully capture intra-regional diversities. For example, "ownership coordination" is mostly applicable to corporations with complex ownership structures (Hotho, 2014). But, in sectors and countries dominated by small and medium-sized firms, horizontal and vertical integration is minimal, with control normally exercised through informal, non-ownership coordination strategies. In addition, employee relation is extended to capture how employees within the businesses relate with dairy producers and how this relationship contributes to the formation of distinctive business systems.

4.2.3 Distinguishing business systems

Based on the above indicators, (Whitley, 2000, 1999) developed a typology of six distinct business systems, described in Table 4.3. This includes *Fragmented* business systems characterised by high direct control and by low ownership and alliance coordination (Whitley, 1999). This business system has low cooperation among firms, and markets are highly competitive, while trust is low among firms. *Coordinated industrial* business systems are characterised by smaller firms with more extensive alliance integration, depicted by their readiness to share resources and opportunities. *Compartmentalised* business systems have high ownership coordination and low non-ownership coordination. Such business systems are enabled when strong formal institutions result in extensive market contracting, but arms-length state involvement discourages long-term commitment among economic actors (e.g., O'Sullivan, 2000; Richardson, 1972).

State-organised business systems have high ownership coordination, mainly depicted by direct owner control. *Collaborative* and *highly coordinated* business systems are characterised by strong interconnections and risk-sharing among economic actors (Whitley, 2000)**.** Firms in these business systems develop more durable relations with customers, suppliers and technology providers (Whitley, 2007). Similarly, a stronger reliance on credit encourages closer relations with capital providers. In both systems, the state encourages the establishment of intermediary associations, and employer-employee relations are more collaborative. Whitley's categorisations were used as a basis for analysis, and where appropriate, the business systems labels were adapted to the research findings.

Table 4.3. Types of business systems

Indicators	Fragmented	Coordinated industrial	Compartmentalised	State organised	Collaborative	Highly coordinated
Role of state and state business Relationships						
The dominance of the state and its willingness to share risks with private owners	Low	Moderately local	Low	High	Moderate	Moderate
State relationship with collective intermediaries (e.g., cooperatives)	Low	Moderately local	Low	Low	High	High
The extent of formal regulation	Moderate	Low	High	Low	High	High
Ownership coordination						
Owner control	Direct	Direct	Market	Direct	Alliance	Alliance
Ownership vertical integration	High	Low	High	High	High	Some
Ownership horizontal integration	Low	Low	High		Moderate to high	limited
Non-ownership coordination						
Alliance coordination of production chains	Low	Moderate	Low	Moderate to High	Limited	High
Collaboration between competitors	Low	Moderate	Low	Low	High	High
Alliance coordination of sectors	Low	Low	Low	Low	Low	Moderate
Employment relations and work management						
Employer-employee interdependence	Low	Moderate	Low	Low	Low	High
Delegation to and trust of an employee	Low	Moderate	Low	Low	Low	Moderate

Source: Adapted from (Hotho, 2014; Whitley, 1999)

4.3 Research context and design

4.3.1 Policy context

The Tanzanian government identified dairy as a priority growth sector in its Livestock Master Plan (Michael et al., 2018). Yet, while the Tanzanian state directly engages in many other priority sectors, it minimally participates in the dairy sector. Before independence, dairy production and milk processing were largely private-sector-led, but most dairy businesses were nationalised under

the post-colonial *Ujamaa system* (Kurwijila, 2001). However, under the liberalisation reforms of the 1980s and 90s, the government divested its interests and deregulated prices (Kurwijila, 2001). Later, agricultural and livestock functions devolved to local government authorities (LGA), who gained autonomy from sectoral ministries. Because livestock officials are primarily accountable to LGAs, local politics and alliances – rather than sectoral priorities – often dictate how dairy development is implemented in practice.

Tanzania's national climate change policies are aligned with long-term development plans and investment strategies, primarily the Tanzania Development Vision 2025. Tanzania's overarching climate targets are described in the Nationally Determined Contributions (NDC), including an action strategy for delivering on commitments under the Paris Agreement (URT, 2015a). The Tanzania National Climate Change Strategy (NCCS) of 2012 outlines mitigation strategies within the livestock sector, "which include manure management practices, promoting appropriate technology for animal feedstuff production and improving rangelands productivity and complementary activities" (URT, 2012, p. 65). More specific guidelines on mitigation in the livestock sector are given by the Tanzanian Climate Smart Agriculture Guidelines (2017–2025). Ideally, the national strategy is translated into sector-specific plans, labelled as Nationally Appropriate Mitigation Actions (NAMA). As of 2021, there is no NAMA for the livestock sector in Tanzania.

Other key sector-level policies include the National Livestock Policy (2006), Kilimo Kwanza (2009), Livestock Development Strategy (2010–2015), The Dairy Industry Act (2004), Tanzania Livestock Modernisation Initiatives (2015) and the Livestock Master Plan (2017). While these sectoral guide interventions, they offer a generic technical outlook on livestock development in which the primary goal is intensification through technological diffusion. However, linear and technocentric approaches evidence little consideration of political-economic processes or implications of intensification. In addition, the implementation of current policies is faced with varying challenges, which include a multiplicity of functions across government agents, lack of legal rationale on implementation procedures, lack of clear coordination mechanisms, accountability and transparency mechanisms for government agencies and a disconnect between national and local government authorities priorities on implementation, monitoring and financing of national-level policy directions and strategies (Nachmany, 2018).

In Tanzania, household milk production is largely for household consumption (90% of total produced milk). Marketed milk is sold directly to neighbours (86%), small-scale milk traders, and collective bulking centres account for 12%, and 2.4% of milk is sold as processed products (Lunogelo et al., 2020). Approximately 50% of processed products are imported. Between 2012 and 2017, a total of 105,993,179.31[1] Liquid Milk Equivalent (LME) amounting to 116,004,960,548.5 TZS was imported (TDB, 2018). For instance, in 2016, imported milk products included milk powder (58%), Ultra Heated (UHT) milk (26%) and other products (16%) (Lunogelo et al., 2020). However, intending to protect local milk producers, the national government raised the import duty in 2018 from TZS 150 to TZS 2,000 per kg, this move affected the cost of reconstituted milk using milk powder, and, in turn, the proportion of imported milk products reduced (Lunogelo et al., 2020). This resulted in increased local demand for processed products and in turn, resulted in increased raw milk prices, especially in regions where raw milk is transformed into processed products.

4.3.2 District selection

This study analyses and compares business systems across four study sites, covering a range of dairy systems (e.g., intensive, semi-intensive and extensive), summarised in Table 4.4. Study sites were selected for their production potential, agroecological significance and relevance to national dairy development priorities. The four districts were also expressly selected to capture geographic and economic differences to enhance external validity in identifying distinctive business systems (Whitley 1999). The districts differ significantly in terms of production systems, agroclimatic conditions, socio-economic profiles, and market maturity. Across the districts, Rungwe had the highest proportion of people living under the poverty line (32%), while Mufindi and Njombe had the lowest proportion of people living under the poverty line, at 24% and 25%, respectively (URT, 2016b, 2015c). Rungwe district had the smallest area and the highest population density at 163 persons per kilometre as compared to other districts, Njombe (34), Mufindi (45), and Mvomero. Rungwe, Mufindi and Njombe had almost similar agroecology with a combination of highland zone and low land zone, while Mvomero had the lowest proportion of highland zone and a higher proportion of woodland and savannah agroecology (URT, 2016b, 2016c, 2015c, 2014a, 2013a).

[1] 1USD = 2300TZS as at the time of the survey in 2018

Table 4.4. District characteristics

	Rungwe	Njombe	Mufindi	Mvomero
Agroecology	Highland zone 18%, midland zone (62%) and low land zone (20%).	Highland zone and low land zone	Highland zone and plateau	Highland and mountainous zone 25%, Miombo woodland 20% and the remaining is Savannah River line basin
Precipitation [mm/yr min/max]	900-2700	600-1600	840-2200	500-2000
Altitude [M above sea level]	770-3000	1700-2100	1500-2100	300-2300
Poverty: [% of people living below the poverty line]	32	25	24	No data
Gini coefficient[2]	34	32	43	No data
Population density [Persons /km$^{2]}$	163	34	45	43
Population [Persons]	339,157	216,010	317,731	312,109
Area km^2	2078	6366	7123	7,325
Number of households [Number]	83,509[3]	52, 178[4]	52,178	72,519
Farmgate milk per litre [TZS][5]	600-800	600-1000	800-1000	800-1200
Main production system	Intensive	Intensive	Semi-intensive	Extensive
Amount of milk	Surplus	surplus	deficit	Seasonal dependent
Presence of processors	Privately owned milk factory	Community-owned milk factory	None	None
Price setting main driver	Processor and traders	Processor	Producers	Producers and collection centres
Proximity to an urban centre [km]	Mbeya 50km and Kyela 20km	Njombe town 1 km	Iringa 80km	Morogoro 50km
Number of dairy cows [Number]	55,337	7,784	6,140	1,923
Indigenous cattle [Number]	22,804	59,195	81,162	65, 064

Source: District socio-economic profiles: Mufindi (URT, 2015b, 2013b), Mvomero (URT, 2018), Njombe (URT, 2016b, 2014a), Rungwe (URT, 2015c, 2015d); 1USD = 2300TZS as at the time of the survey in 2018.

In terms of market development, Rungwe district is characterised by highly commercial and competitive milk markets, with most households owning at least one cow. Njombe is comparatively intensive due to 30+ years of dairy development interventions. As a result, it now has a well-established farmer cooperative and a large milk processing plant that is co-owned by the farmer cooperative and the Njombe Local Government Authority. Mufindi has more semi-

[2] Gini coefficient: is, a measure of statistical dispersion intended to represent the income distribution of and is the most commonly used measure of inequality. A value of 0 represents absolute equality and a value of 100 represents absolute inequalities.
[3] Combined Rungwe DC and Busokelo DC both councils make up Rungwe district
[4] Combined Njombe DC and Njombe TC both councils make up Njombe district

intensive systems but lacks a dynamic milk market due to net milk deficits. This can be partly attributed to its more crop-oriented economy in which animals primarily serve as a source of traction and crop manure.

4.3.3 Data collection and analysis

This study draws on qualitative data designed to unpack the contextual factors that shape business systems across the four study sites. Data collection methods include key informant interviews, actor mapping and document review. The key informant interviews captured historical and structural factors shaping the local dairy business systems. In each district, a list of relevant stakeholders within the dairy value chain was first developed with local government livestock officials. The list was categorised into farmer organisations, government officials, development organisations, processors, and traders. Representatives from each category were then purposively selected based on their knowledge of the topic and the specialised nature of the information required to answer the research questions. Purposeful sampling is imperative when looking for respondents with specialised knowledge, practical experience and understanding of key aspects of the study (Etikan et al., 2017). In each district, all relevant stakeholders in each category were interviewed, eliciting data on the local historical dairy development trajectories, antecedents and business systems parameters summarised in Table 4.5.

Table 4.5. List of interviews

	Dar es Salaam	**Morogoro**	**Mufindi**	**Njombe**	**Rungwe**	**Total**
Number of processors	N/A	1	N/A	2	1	4
Milk cooling/traders	N/A	4	N/A	1	0	5
Mtindi processors	N/A	N/A	N/A	1	2	3
Farmer organisations	N/A	N/A	4	5	7	16
Livestock officials	0	1	1	1	2	5
Development organisations	0	0	1	1	1	3
Parastatals/ para government	2	0	0	0	0	2
Total	2	6	6	11	13	38

Note: "N/A" means that there are no respondents in the set category within the district; Dar es Salaam was only a focus for the national level actors and not LGA officials or milk traders and processors.

Further data on vertical and horizontal coordination and employee relations were generated using actor mapping approaches. Actors were asked about the main stakeholders they interact with and the nature of that interaction. In total, 38 actors were interviewed through actor mapping and key informant interviews across the four districts. The key informant data were collected in two rounds

first initial discussions were held with all the key informants across the districts in June 2018 to understand their role, historical and structural structures shaping dairy in their district, a second detailed interview also included the actor mapping was conducted in September–- October 2018 across the four districts. Finally, after initial data analysis, participatory workshops were conducted in Njombe, Rungwe and Dar es Salaam (in February 2019) to validate findings and elaborate on the relationships of value chain actors and broader sectoral/political-economic context. These involved a total of 110 participants.

Interviews were translated from Swahili and transcribed to English. Data from the key informant interviews were coded into sub-indicators, following the framework used by (Whitley, 1999). plus, our additional sub-indicators on dairy commercialisation and intensification (see Tables 1 and 2). Data coding was done using ATLAS.ti, and it was thematically organised following the analytical framework (see Tables 1 and **2**). We thus characterised the districts' business systems through a synthesis of qualitative data elicited from interviewees.

4.4 Results

This section first presents the empirical results for each of the four study districts. This involves categorising each business system separately, structured per the BST framework. The concluding section compares the four-business system and evaluates how conductive each business system is to LED's dual commercialisation/intensification strategies.

4.4.1 Rungwe district

Role of the state and state business relationship

In Rungwe, the dairy sector is driven by privately owned milk traders comprised of one lead firm (ASAS Dairies), numerous medium and small-scale traders, and some farmer milk marketing cooperatives. The local government does not directly engage in economic activities in the dairy sector, for two reasons. First, the state's relationship with collective intermediaries is weak, with the local government mainly fulfilling, but not exceeding, their primary mandate to facilitate input provisioning and any market-related interventions. However, competition between cooperatives often leads to conflict between farmers with divergent loyalties. Consequently, the local government often acts as an arbitrator. Second, formal regulations (e.g., taxes, regular inspection of products and premises) are selectively enforced. Because the formal processors and not informal

traders are the only ones registered with the national government, centralised activities related to business registration, inspection, and national income tax collection focus only on formal actors. ASAS, as the main private-sector processor, noted duplication of taxes and regulations across various national government departments, as well as double taxation from both national and local governments. The lead firm also noted that most of the taxes and standards applied to them were not extended to smaller traders. The smaller traders were, therefore, able to offer a higher milk price to farmers, which the formal sector considers unfair competition.

Ownership coordination

Ownership coordination in the Rungwe district is characterised by direct ownership control for ASAS and alliance control for the producer cooperatives. Farmer cooperatives have historically been instrumental in organising milk marketing in Rungwe, strengthening farmers' bargaining power and reducing transaction costs related to coordination and service delivery. Two main cooperatives source milk in Rungwe: *Mungano wa Wafugaji wa Maziwa Rungwe* (MUWAMARU), affiliated to ASAS and *Milk Cooperative Union* (MCU), supported by the East Africa Dairy Development Project (EADD[6]). MUWAMARU is a cooperative that helps coordinate milk sourcing from more than 24 independent farmer groups for ASAS (at the time of this study). MCU bulks, chills and sells unprocessed milk to Njombe Milk Factory (NMF), a community-owned milk factory based in Njombe district (see next section for more details), or to local traders in Rungwe. Most local traders are not diversified, trading only in fresh milk or fermented milk products, and they do not engage in any further processing. However, they command a big market share of consumers in Rungwe and neighbouring urban towns (e.g., Kyela and Mbeya). ASAS, on the other hand, specialises in pasteurised fresh milk, fermented milk, yoghurt, and long-life milk. The long-life milk helps resolve seasonal milk oversupply issues, meaning the processor – in contrast to many others – can still source milk from farmers during a supply glut. There is limited vertical integration across the actors, except for ASAS, which has a retail shop and a farm in Iringa. The farm's production falls significantly short of ASAS' demand, but also serves as a demonstration farm and a source of quality dairy bulls for farmer groups who sell to ASAS.

[6] EADD is a dairy development project implemented by Heifer International in partnership with other organisations in the southern highlands in Tanzania (Njombe, Mbeya and Iringa regions). The project supported farmers through training and linking farmers to market through the milk hub model. The goal was to help families move out of poverty through more profitable production and marketing of milk.

Non-ownership coordination

There are high levels of vertical coordination between cooperatives and their members. Private traders offered the highest milk prices at 700-800 TZS compared to the cooperatives, which offered between 600-650 TZS. However, they do not collect large volumes, and priority is given to select long-term suppliers. Much of their business is enabled by Rungwe's proximity to the Malawi and Zambian borders, as well as the thriving urban market in nearby Mbeya town. Differences in milk volumes across seasons result in higher prices during the dry season, with variability ranging from around 50-100 TZS per litre of milk. During the dry season when milk volumes are low, some traders use the pricing mechanism to get more milk by increasing their buying price. Due to high competition, horizontal coordination is limited. In contrast to many other countries, many cooperatives in Tanzania do not re-sell milk at a profit to processors. Instead, the cooperatives coordinate and facilitate on behalf of a processor. For instance, there is high coordination between MUWAMARU and ASAS. MUWAMARU coordinates milk sourcing, bulking, transportation and payments. This strategy reduces transaction costs for ASAS and facilitates extension services. Farmers in MUWAMARU have shares within the cooperative and are registered as members who sell milk to ASAS. ASAS, on the other hand, contributes ten Tanzanian Shillings (TZS) per litre of milk bought towards MUWAMARU's operational costs. MUWAMARU usually uses these funds for the daily running of the union and capital investment, such as purchasing vehicles for milk transportation. ASAS has a dedicated extension staff who helps support its farmers while the guaranteed market serves as an incentive for farmers to increase productivity.

Farmers affiliated with MCU have benefitted from EADD support. EADD supported the expansion of NMF and forged the MCU-NMF relationship. It also fully subsidised the establishment of ten cooling centres across the Rungwe district to facilitate bulking. The cooling centres are fully equipped with a cooling tank, backup generator and required milk quality test equipment. However, at the time of this study, only three cooling centres were functional. EADD's investment in the cooling centres was motivated by the need for higher farmgate prices and to provide an aggregation point that would permit buyers to procure milk in bulk. However, these objectives have yet to be achieved, with reliable milk buyers and effective cooling centre leadership missing. Despite MCU payment delays, MCU's farmers rarely shift allegiances (e.g., to MUWAMARU). MCU and MUWAMARU also compete for farmers on milk price, service delivery and geographic reach. When one cooperative increases milk price, for example, farmers

selling to others will demand an increase too. Lock-in strategies are more socially embedded, with farmers loyal to their constituent cooperatives as opposed to formally enforced. Farmers affiliated with MCU are shareholders in the union, which further raises switching costs.

The misalignment of priorities between private investors and donor organisations, therefore, presents a major coordination challenge. For instance, the additional cooling centres by EADD saw increased volumes of collected milk from farmers through MCU. However, there was no direct link to a reliable buyer able to absorb all the extra milk since major milk buyers in the district (e.g., ASAS) tend to purchase only through their farmer organisations. The lack of coordination between these actors leads to competing and overlapping interventions and milk losses for farmers who get stranded with extra milk in the case of MCU and delayed payments. ASAS, also strongly criticised EADD's approach to market development, claiming that subsidisation creates unfair competition and undermines the development of a functional commercial sector. While such interventions might be justifiable in the absence of existing markets and infrastructure, creating new production and marketing structures in comparatively mature markets tends to have a disruptive effect by crowding out private investment.

Employment relations and work management

Employer-employee relations differ across various enterprises. ASAS relies on skilled employees for managing milk collection, quality tests, bulking and offering extension services to farmers. ASAS has strong direct control over most of the decisions made by the directors. ASAS employees have set job descriptions and compensation structures. Small businesses are controlled by family members, which allows them to make quick decisions to respond to changing market dynamics and are more relational to the milk producers. On the other hand, cooperatives are typically more democratically managed and run by group leaders who, despite milk production experience, often lack basic business skills. Leaders are rarely on the payroll and manage cooperative activities as a secondary livelihood activity. Cooperative leaders must consult others before making any strategic decisions, which is not always advantageous within a dynamic and rapidly changing dairy industry. Larger farmer cooperatives are less relational to milk producers, often meeting only during the annual general meeting or training days.

4.4.2 Njombe district

Role of the state and state business relationship

NMF, a community-owned processing plant, has the largest market share in Njombe, followed by ASAS and a few independent traders. The LGA in Njombe is more actively involved in the district's milk economy. The LGA, through the District Agricultural Development Plans (DADP) fund, made a direct equity investment in NMF. The LGA is also represented on the factory's board of directors and contributes to the daily running of the factory. The factory also enjoys other benefits, such as local tax waivers granted by the LGA. However, NMF must still adhere to national standards and regulations, which the factory noted were expensive to comply with and redundant at times. The LGA is vested in NMF's success, mediates on NMF's behalf, and facilitates its business activities. However, it still performs traditional regulatory functions for other actors within the district, resulting in a conflation of roles.

These state-business relationships in Njombe are influenced by development donors, particularly Heifer International, which has invested heavily in farmer training, organising farmers into cooperatives through the milk hub model and contributing to NMF expansion over recent decades. Under this model, milk hubs function as one-stop shops for farmers, offering bulking, training, and inputs financial and marketing services (ILRI, 2013). Heifer International's state-like role has, in certain areas, crowded out LGA extension services. However, their presence has helped institutionalise the Heifer-in-Trust[7] model, which the LGA now also promotes. This unique donor support has contributed to farmers' adoption of dairy intensification practices. Moreover, Heifer International facilitates dialogue and coordination between dairy stakeholders facilitating intensification in the district.

Ownership coordination

Interestingly, Njombe has high ownership coordination, as well as high alliance owner control, with the lead firm in the district – NMF – being co-owned by various stakeholders. The ownership of NMF includes farmers through their Njombe Livestock Farmers cooperative (NJOLIFA), the Catholic church, Njombe District Council, Njombe Town Council, and the Italian NGO CEFA. In

[7] Heifer-in-Trust model: is a livestock in-kind credit investment model introduced by Heifer International. Farmers are provided with a young cow (heifer), based on an agreement that the household would pay the credit back by giving either the first or second offspring cow to the next eligible household in the same community.

2004, with the support of Caritas[8] (The Catholic Church's development and social service organisation), NJOLIFA sourced funding from CEFA[9] and the private dairy company Granarolo to set up a processing factory. Granarolo played a significant role in the construction and running of the company in the early years by providing capital to construct the factory, as well as through community capacity building for milk production and processing. Granarolo gradually ceded management and strategic decision-making to NJOLIFA, which now controls much of NMF's daily activities. NMF is now characterised by significant vertical integration, with members of NJOLIFA socially obligated to sell to NMF. The social obligation is an informal need for cooperative members to sell milk to their community-owned processing factories as opposed to other external buyers.

There is moderate horizontal integration in NMF, with half the processed milk used to make cheese, 10% for yoghurt and fermented milk and the rest sold as fresh milk. Because cheese is an aged product that does not go to market immediately, it is often difficult for the company to have sufficient liquidity to make timely bi-weekly payments to farmers, frequently resulting in delayed payments. During the EADD project period, Heifer International bought fresh milk from NMF for a school feeding program, ensuring a steady flow of cash to pay farmers through a fixed market. *EADD* was implemented by Heifer International, in Njombe, Mufindi and Rungwe. The project focused on providing training to farmers on good dairy management practices and enhancing collective organisation under farmer-managed milk hubs. The close collaboration between donors, cooperatives and local government in the dairy sector, although beneficial to NMF, disadvantages other private investors who allege that sustained external support of NMF affords it an unfair advantage and undermines competition.

Like in Rungwe, ASAS also has a presence in Njombe, albeit with a comparatively small market share. It sources milk from cooperatives directly. As discussed in the previous section, ASAS enjoys significant direct ownership control.

Non-ownership coordination

[9] CEFA Italian NGO that supports poor communities https://www.cefaonlus.it/en/: Granarolo: https://www.granarologroup.com/projects/africa-milk-project

ASAS is the main competitor for NMF. Because of NMF payment delays, ASAS attracts farmers that (should) sell to NJOLIFA. ASAS offers timely payments directly to farmer groups' bank accounts or through mobile money, compared to NMF's cash payments at the milk factory, which are received by group leaders on behalf of their members. Market penetration in Njombe remains a challenge since all dairy farmer groups in Njombe are part of NJOLIFA. This was a requirement to access EADD and governmental support. Even NJOLIFA farmers selling to ASAS remain part of NJOLIFA and thereby still receive EADD training and extension support. NMF does not offer any extension services or input provision services but relies on services offered by both LGA extension officers and EADD staff. NJOLIFA has over 1,200 active farmers, and they all receive (or have received) support from EADD. This strong representation structure and sustained external support, especially in extension and farmer training, has resulted in farmers upgrading their dairy production practices, by adopting more LED practices in fodder production, proper feeding and animal husbandry practices. Farmers' marketing agreements with NMF are based on milk prices and set milk quality standards that must be met by producers. However, there are no quality-based buying systems where farmers with higher milk quality are offered premium prices. Volumes delivered by farmers vary. This results in supply gluts during the wet seasons and supply constraints during dry seasons. In several instances, NMF was unable to absorb excess supply. In such instances, more farmers sell their milk to ASAS, which can absorb large volumes of milk in both seasons.

Despite monopsonist market conditions, prices between ASAS and NMF vary. Farmers are price takers, whether selling to NMF or ASAS. Milk margins depend on the farmer's location. In areas closer to ASAS bulking centres or the NMF factory, margins are higher because of lower transportation costs. Over the years, NMF has received funding from other organisations, including the SAGCOT Catalytic Fund and Heifer International. For instance, NMF received additional funding from Heifer International through the EADD project in 2018-2019 to expand its processing capacity from 5,000 to 20,000 litres per day. Despite heavy investments from different donors, local government, and farmer cooperatives – denoting high alliance-based horizontal coordination – NMF is still not self-sustainable. The biggest constraint for NMF is the lack of business skills to profitably operate the company. Much effort is put into infrastructural upgrading of the factory and less effort is put into making sure the staff's marketing and financial management are well developed.

Vertical and horizontal coordination in Njombe – through the collaboration between Heifer International, LGA, the Catholic church and other donor organisations – has led to farmers upgrading dairy production practices. This has emerged from long-term collaborative interventions in Njombe that started in the early 70s through the Heifer-in-Trust model. Although this collaboration advanced production practices, marketing continues to be a bottleneck, with unreliable end markets and delayed payments. Furthermore, farmer training focused on supply-side barriers to the uptake of better practices rather than taking on demand-side functions and tackling marketing challenges. ASAS, on the other hand, has not contributed as much to the long-term upgrading of practices but can effectively address marketing and payment challenges.

Employment relations and work management

ASAS' cooling centre is run by skilled personnel who coordinate milk collection and extension services. ASAS is also keen to advance its staff's technical excellence in coordinating milk quality checks, milk bulking and payment to farmers. This includes leveraging technology to ensure accurate data capture on milk volumes and timely and accurate milk payments. NMF is also run by skilled employees, led by a manager with oversight from a board of management. There is low employer-employee interdependence and trust in skilled workers in running NMF. There is poor integration of technology, and farmers often complain about incorrect milk records and delayed payments. Local NJOLIFA leaders, who initiated and facilitated the formation of NJOLIFA, have been instrumental in running NMF for over 15 years. Their vision and personal commitment contributed to the formation of NMF and a substantial farmer cooperative NJOLIFA. Upon establishment of the NMF, NJOLIFA also established its premises within the company compound and participated in most major decisions made by the factory. At the time of this study, NJOLIFA leaders had not held cooperative elections for some time, overstaying their leadership period and violating the NJOLIFA constitution. Furthermore, NJOLIFA lacked a feedback mechanism to allow members to participate in decision-making, thereby reducing the responsiveness of NJOLIFA leaders to the needs and interests of its members. There is, therefore, a degree of elite capture and farmers' interests are not well represented (at the time of this study). To address this, EADD lobbied farmers and the local government to change the old NJOLIFA leaders and board members when the factory was expanded (2018–2019), aimed at countering elite capture.

4.4.3 Mufindi district

Role of the state and state business relationship

The state is not an economic actor in the dairy sector in Mufindi. No processors source milk in the district either. Most of the milk is sold informally, and a small proportion is sold to local milk hubs. Because the market is informal, no national-level taxes are levied, nor are national regulations enforced other than milk hub registrations, where local government plays a regulatory role. This ensures that the milk hubs adhere to relevant health regulations, and milk is transported in appropriate aluminium cans instead of plastic cans. The formation of the milk hubs in Mufindi was coordinated by EADD in 2015–2019. All four milk hubs in Mufindi unite to form Mufindi Dairy Cooperative (MUDCO), a farmers' union. Although the DADPs Heifer-in-Trust model was also implemented in Mufindi, its effects were not as widespread as in Njombe. As such, only a small proportion of households practice intensive dairy production. A mix of factors contributes to this, including a higher interest in non-dairy agricultural value chains, no long-term coordination between donors, LGA and the community to ensure upgrading in dairy, and less developed market structures. In recent years, the LGA has partnered with development organisations to provide dairy extension and training services to farmers. For instance, the Mafinga Town Council has seconded its livestock extension staff to the African Dairy Genetic Gains (ADGG) project, which facilitates the government to identify the genetic potential of their dairy herd and extension support to farmers. This has been quite effective in reaching farmers and has been instrumental in ensuring farmers adopt at least some intensification practices, especially improved breeding.

Ownership co-ordination

Most milk is sold directly from producer to consumer because farmers receive higher prices and incur fewer transport costs if selling directly. The small amount that is not sold directly is sold to EADD milk hubs rather than informal traders. The milk hubs are under alliance control while individuals are under direct control. Informal traders are not prevalent or not engaged in direct sourcing because of the high transaction cost of aggregating small volumes from individual farmers. The milk hubs are owned and operated by ward-level farmer cooperatives. Other smaller traders also buy milk from farmers and sell it to urban consumers, evidencing direct ownership control. None of the milk buyers engages in milk processing or value addition, evidencing limited vertical integration. The farmer groups chill milk and sell it to other traders and consumers or

ferment it to sell as *mtindi.* The farmers take turns in offering pro-bono labour in running the milk hubs, while the elected leaders make the decisions on how to run the milk hubs on behalf of other farmers.

Non-ownership co-ordination

There is moderate vertical coordination between producers and the milk hubs. This is through informal contracts, where members sell their milk to the hubs. The milk hubs coordinate input delivery (e.g., ECF vaccines or bulk buying concentrates) for members, as well as training and marketing. Although the hub can collect milk from non-members, most of the milk is sourced from members. The hubs collect milk, and then pasteurise it or make *mtindi* to sell to local consumers. Each milk hub collects an average of 150–300 litres per day. Two milk hubs are located along the tarmac road in areas where intensive dairy production is higher, while the other two are in more remote villages. The milk hub model in Mufindi differs from those in Njombe and Rungwe, in that they bulk all their milk, process it and sell it to consumers rather than to large processors.

There is a high level of collaboration between the milk hubs and minimal competition between dairy actors in Mufindi. Because the farmer organisations in Mufindi offer high milk prices compared to other milk hubs in other districts, and the volumes of milk available in the district are low, processing companies have little interest in sourcing milk from this district. For instance, ASAS is located 80 km from Mufindi. However, ASAS travels approximately 400km away to collect milk in the Rungwe district at 650TZS per litre as opposed to 800–1,000TZS in Mufindi. Farmers in Mufindi have many alternative income options, meaning dairy is not the most remunerative option. This contributes to low supply and responsiveness to high prices.

Employment relations and work management

The milk hubs exhibit high employer-employee interdependence. Farmers are trying to navigate the milk-selling business, while they often lack both business skills and technical skills in milk processing. Although some leaders have undergone milk processing training, they are not available daily to oversee the *mtindi* production process. This results in high milk losses, especially while making *mtindi*. Besides the administrative staff, who have a salary, farmer cooperative leaders provide labour to the milk hubs without pay. Cooperative leaders (who are also farmers) actively sensitise members on the importance of selling milk to the hub.

4.4.4 Mvomero district

Role of the state and state business relationship

In Mvomero, the dairy sector is driven by small traders who manage milk collection and own artisanal cooling centres operated by one or two employees. The milk is chilled and sold to distant traders and processing plants during the wet season. Because the processing firms that buy in Mvomero have no infrastructure in the district, the state does not interact directly with processors. Due to the informal nature of the sector, regulatory enforcement is minimal. The cooling centres require only a business license, and workers need to pass a health test and ensure the premises meet health and safety standards. Only business licensing requirements is enforced. However, in contrast to many other milk-producing districts, the state does not facilitate or regulate milk marketing, and donors have not shown much interest in Mvomero's dairy sector. The state is, however, present in collecting levies from local markets when pastoralists sell live animals. The state also coordinates and governs cattle movement across villages, limiting the movement of cattle across wards. If herders need to move the cattle, they must pay a fee to the village council, thus increasing the transaction cost for herders in search of fodder.

The local government, through village governments, does arbitrate between farmers and pastoralists over land and crop damage disputes. Village land is governed by the Village Councils, who make decisions on land use and allocation based on customary law. Although pastoral milk producers are transhumant pastoralists who have lived in the district for over 30 years, village leadership predominantly consists of farmers hesitant to allocate pastoral households sufficient grazing land for fear they will destroy crops and reduce available land for farming. This results in conflict between pastoral and farming households over land access, especially during the crop growing season.

Ownership co-ordination

Privately-owned cooling centres are characterised by direct owner control. There are four cooling centres located in the Dakawa ward, each aggregating between 1,500–2,000 L/day from pastoral producers. Most of the milk in the district is produced by pastoral households who own large herds of cattle which also depicts direct owner control. This makes milk availability and marketing heavily contingent on the seasonal availability of grass and access to grazing lands, as well as changing movements of pastoral communities.

Non-ownership co-ordination

Cooling centres are not vertically integrated, meaning they just trade in externally sourced milk and do not retail or produce. Traders rely on motorbike milk aggregators to bulk milk from producers, who are not organised in groups. Therefore, independent motorbike milk aggregators aggregate milk from various households and deliver it to the cooling centres at a markup. The aggregators, therefore, help to overcome the high transaction and coordination costs in milk sourcing within the pastoralist community. Cooling centres do not offer any input services or extension services to producers denoting low vertical coordination. There are no fixed agreements between cooling centres and motorbike milk aggregators and pastoralists. The motorbike milk aggregators can supply milk to any of the cooling centres and they often sell milk to more than one cooling centre to spread their risk. In the dry season, motorbike milk aggregators supply higher volumes to the cooling centre offering higher prices. There are no formal agreements, and all transactions are made based on trust. This informality means that the sourcing arrangements can be easily adapted to changing production and environmental conditions. For instance, during the dry season, producers inform motorbike milk aggregators of their movements, and the motorbike milk aggregators adjust their collections accordingly. Motorbike milk aggregators ensure pastoralists adhere to milk quality standards. The motorbike milk aggregators perform the required tests for each household before aggregating the milk from several households.

Horizontal coordination is seasonal and context-dependent, with high coordination among milk cooling centres during the wet season and low coordination during the dry season. The cooling centres collaborate in bulking milk, especially in response to a technical failure or to attain a specified market demand. During the dry season, the milk cooling centres sell larger milk volumes to consumers or other high-value traders, such as retailers selling milk in urban centres, including

Morogoro town (45 km away) or Dar es Salaam (230 km away). Traders maximise profits during the dry season, when the margins are higher, and create savings that will cover operational costs during the wet season when milk margins are lower. Because milk prices are lower during the wet season, some large processing firms return to purchase milk from the cooling centres, and then temporarily exit the market in the dry season. The processors buying milk in Mvomero are Tanga Fresh, Dar Fresh and Shambani Milk Companies. They do not have milk collection infrastructure set up in Mvomero, but source twice or thrice a week during the wet season. In the dry season, if volumes are low, the processors temporarily suspend their collections. All milk sold at the cooling centres must adhere to set enforced quality standards. Milk quality checks are performed at the household level by motorbike milk aggregators and again at the cooling centre before the milk is received. The adherence to quality standards helps bridge the divide between the formal and informal sectors.

Based on volumes and milk prices cooling centres owners inform the milk processors and if the volumes and prices are agreeable to both they set an agreed collection routine including time, date and volumes. Although run by small traders, the milk eventually gets to national distribution channels. Traditional pastoral systems account for over 70% of total milk production in Tanzania (Kurwijila, 2001). However, pastoralists are not prioritised in dairy development policies, which focus on (semi-) intensive production systems. Nevertheless, the sector presents the highest leverage in increasing dairy production potential in the county. Because it has the highest potential to increase productivity through the implementation of innovative upgrading practices that align with pastoralists' needs, such as improved rangeland management practices and land access mechanisms.

Employment relations and work management

Due to the seasonal variability in milk volumes and prices, cooling centre owners rely on their employees to effectively manage the milk supply, especially in the dry season. The business is highly contingent on employee willingness to improve task performance, especially in milk quality checks and their innovation in attracting and retaining milk suppliers during the dry season (motorbike milk aggregators bulking milk from pastoral households). Therefore, the cooling centres rely on worker commitment to coordinating milk sourcing, cooling and bulking. Compared

to other districts, Mvomero cooling centres are independent and privately owned and not co-owned by producers. Consequently, producers experience less lock-in in terms of their marketing options.

Table 4.6. Comparison of business system types found in the Tanzanian dairy sector

Business System	Fragmented (Rungwe)	Collaborative (Njombe)	Closed (Mufindi)	Coordinated -artisanal (Mvomero)
Role of state and state business relationship				
The dominance of the state and its willingness to share risks with private owners	Low state dominance no risk-sharing	Moderate LGA dominance, LGA Coo-owner on NMF moderate risk sharing	No state dominance, moderate risk sharing	Moderately local
State relationship with collective intermediaries (e.g., farmer cooperatives)	Low	High	Supportive	No collective intermediaries yet
The extent of formal regulation of markets (Taxation and enforcement of milk quality standards)	Strong control for processors, moderate control for private traders	Moderate control	Less control	Less control for business traders
Ownership coordination				
Owner control	Direct- and alliance	Alliance	Alliance/ Direct	Direct
Ownership vertical integration	Low	Moderate	Low	Low
Ownership horizontal integration	Low	Moderate to high	Low	Low
Non-ownership coordination				
Alliance coordination of production chains	Low	Limited	Low	Moderate
Collaboration between competitors	Low	Low	Low	Moderate
Alliance coordination of sectors	Low	Low	Low	Low
Employment relations and work management				
Employer-employee interdependence	Moderate	Low	Moderate	Moderate
Delegation to and trust of the employee	Low	Low	Moderate	Moderate
Dairy commercialisation				
Presence of Lead milk processing factories	One lead firm present	Two lead firms present	None	None
Integration with the national dairy sector	High	High	Low	High
Presence of NGOs and development organisations	Development organisations highly involved	Development organisations highly involved	Moderate involvement of development organisation	Low
Dairy intensification				
Dominant production system	Intensive	Intensive	Semi-intensive	Extensive
Uptake of LEDD practices and availability of inputs and services	High	High	Moderate	Low

Note: Bold denotes dimensions that show a slight deviation from the Whitley (1999) framework.
Source: This study 2018–2019

4.5 Discussion: the fit of LED and business systems

Our results demonstrate the value of the business system approach in understanding complex relationships between globally induced LED strategies and institutions in agrarian business systems (Hotho, 2014). Although the indicators developed by (Whitley, 1999). for analysing a business system that does not neatly fit agrarian conditions, they help illuminate the "distinct and contrasting trajectories of the business system" that shape the geographically defined nature of the economic organisation (Redding, 2005, p. 123). By translating the BST framework to agrarian contexts, we were able to advance previous literature (Hotho, 2014; Prevezer, 2017; Whitley, 1999) and use the approach to assess the likelihood of LED fit with the realities of business systems at sub-national levels. For this purpose, we added two cross-cutting indicators to calibrate BST to agrarian business systems and the intensification and commercialisation pressures associated with LED. The resulting descriptions of the business systems in four districts expose diversity at the sub-national level. The business system perspective typifies this diversity of business systems identified in the Tanzanian dairy sector as *Fragmented (Rungwe), Collaborative (Njombe), Closed (Mufindi)* and *Coordinated Artisanal (Mvomero)* (summarised in Table 4.6). Consequently, this diversity presents different conditions for LED and exposes contrasts with the dominant policy narrative anchored in intensification and commercialisation.

Rungwe district is depicted as a *fragmented* system due to limited state engagement in the dairy sector, direct ownership control, low ownership coordination and low non-ownership coordination. This is evidenced by high competition among businesses and limited inter-business cooperation, which incentivises firms to increase internal efficiencies to maintain competitiveness. As part of the commercialisation trajectory, processors invest in the technical training of farmers to increase productivity and ensure supply. Private sector firms are instrumental in shaping intensification and commercialisation within the *fragmented* system. Private companies have the coordination and entrepreneurial capabilities to incentivise the adoption of technical practices across large groups of farmers and are less susceptible to political and elite capture. This type of business system is quite consistent with LED strategies based on intensification and commercialisation.

Njombe district represents a *collaborative* system. The tandem of government and donor organisations plays a more active role within this *collaborative* system. The state is dominant in

the dairy sector, and there is a high degree of coordination between the government, producers, religious organisations, and the donor community. This has enabled extension support to farmers and investments in upgrading dairy production. Farmers have strong market links, but they are also confronted with high transport costs and delayed payments. In the milk market, a combination of monopsonistic competition and state and donor market interference is visible. Development organisations and the local government are more instrumental in facilitating intensification and market linkage strategies for producers in the *collaborative* system. Although beneficial in areas where market structures are not well developed, this can be detrimental in systems where market structures are well developed, such as the fragmented business system in Rungwe (Kihoro et al., 2021). Such is also susceptible to political interference and elite capture. Excessive reliance on the state in directing strategies and sharing risks, as shown in *collaborative* systems (Whitley, 1999), limits owners' and employees' interest in making strategic decisions, eventually undermining their market competitiveness.

Our analysis characterises Mufindi as a *closed* business system, although there is no exact match with the characterisations by Whitley. *Closed* systems are not intricately linked to the wider national economy but do offer high milk prices to producers. The central feature of a *closed* business system is that the scope of business operations is confined to the district. The system is served by informal marketing systems where most farmers sell to individuals or intermediaries, typically by choice, motivated by either immediate payments, lower transport costs and/or higher prices. Abruptly pushing such systems into formal markets risks disrupting existing economic networks in ways that may not be positive. This is largely because the milk bulking and transportation networks are not well developed. In addition, formalisation of the sector may lead to increased volumes and reduced prices for farmers which would make dairy unattractive compared to other income-generating activities within the district. Intensification is also moderately taken up and farmers prioritise dairy for their household milk consumption and the opportunity to use the manure in other food and cash crops production. The existing milk hubs can play a key role in further sensitising farmers on LED and help farmers to identify diversification efforts that rely on and/or support dairy.

Similarly, the fit with LED is less likely in Mvomero due to the nature of doing business and the architecture of the business system. In Mvomero, the commercial process is shaped by the informal

sector, which operates outside the scope of national policies and regulations. To describe the business system in Mvomero, we propose to add a new category to BST: *coordinated artisanal*. It resembles the *coordinated industrial business* categorisation by Whitley (1999) but operates on a smaller scale and has a less industrial character. Compared to business systems where cooperatives are used to link producers and milk buyers, private traders in *coordinated artisanal* systems such as Mvomero use informal communications and relational strategies to develop market relations. Therefore, social relationships (Wood et al., 2014) and local institutions (Chuku, 2010) are instrumental in shaping the production and LED pathways that are responsive to pastoral production systems- characterised by the movement of cattle in search of grazing land. The absence of the state and donor communities creates an opportunity for independent traders to innovatively solve the transaction and coordination challenges, as well as use this as a source of income. In such systems, private traders can adapt quickly to changes in market demands (Whitley, 1999) and environmental variabilities influencing both milk volumes and prices. Business control and decision-making are more personal than procedural and business owners cannot operate at arm's length (Whitley, 1999). The commercialisation pathway in dominant LED strategies contrasts with these characteristics of the business system, which allow private sector actors to navigate scarcity and volatility found in arid agroecological conditions in Mvomero, which also make the district not amenable to intensification in the short run. However, it is pivotal in commercialisation of milk from pastoral producers and integrating the milk to growing urban consumers. It is unlikely that the *coordinated artisanal* system in Mvomero aligns with the dominant LED narrative.

An inclusive approach to LED attentive to sub-national diversity requires innovative mechanisms to reach farmers who are interested in dairy but are excluded from the cooperatives that link farmers to major corporate buyers and extension support. Exploring this space seems possible in Tanzania because there is no single policy explicitly defining low-emission dairy strategies. Instead, various policies on climate change, national development, and sector-level strategies form a suite of policies that are ideally implemented across ministries, sectors, and levels of government. The suite of policies focuses on modernising the dairy sector using a fluid composite of strategies characterised by a strong role for private sector engagement in rural development and commercialisation (URT, 2015e, 2014b, 2011). The lack of cohesion supports a certain malleability, where policy implementation becomes contingent on local level interpretation.

Donor and government support is often directed towards intensification and commercialisation based on group formation and cooperative development. This approach can be instrumental for service and input provision, and extension support aimed at intensification by strengthening farmers' production capacities. However, in business systems where formal markets are less developed the informal sector continues to play a key role in facilitating the commercialisation and intensification of agricultural production. Innovatively including such actors within the future LED strategies through enhancing their capacities to support farmers through input and service delivery will be instrumental in reaching otherwise excluded regions and producers. We note that although the Tanzanian state was previously a dominant actor in the dairy sector, privatisation has re-configured state-business relations such that the national government currently plays a more remote regulatory role, although it still impacts the sector. For instance, the increase in milk import tax resulted in higher prices, especially for districts like Rungwe where milk is integrated into the wider economy as processed products. Yet, the lack of a distinct policy on LED allows a malleability of implementation practices at the local level. Calibrating global and national climate change strategies to diverse local needs should enhance smallholders' buy-in and contribute to more equitable outcomes from LED. Consequently, LED-strategies should not be understood only as processes of altering carbon and nitrogen cycles but also as processes of engaging diverse socio-economic institutions to shape inclusive and equitable transitions and lower carbon footprint economies.

Chapter 5

Alignment of milk markets and pastoralist production systems: A case study of innovative business practices in Dakawa, Tanzania

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5 Alignment of milk markets and pastoralist production systems: A case study of innovative business practices in Dakawa, Tanzania.

Abstract

The poor integration of pastoral households into milk markets has been attributed to several aspects, including the mobile nature of pastoralists and seasonal fluctuations in milk volumes. Pastoralists also keep their cattle as a store of wealth, meaning they are keener to increase livestock numbers than their productivity. Cumulatively, these aspects make it risky for traders to source milk from pastoral households because of the high transaction costs and the uncertainty of milk prices and volumes. This study evaluates the practice of sourcing milk and the innovative strategies used by several traders to ensure that pastoral households are integrated into milk markets. Methodologically, we use the practice approach, where practices are meaning-making and order-producing activities that result in an institutionalised way of doing. Results show previous market engagement for pastoralists was taking place in a rigid, predetermined context that failed to account for pastoralists' varying production systems. We demonstrate how the skilful performance of traders and motorbike milk aggregators has aligned with the logic and interests of pastoralists. We demonstrate that this alignment capacity can only be realised under specific conditions, which involve aligning with local production systems, coordinating with intermediaries, and having a flexible approach to marketing prices and buyers across seasons. Our analysis demonstrates how economic organisation emerges, not as an outcome of an intentional system design, but by the processes and actions of solving everyday problems. In doing so, this study contributes to more realistic needs-driven business intervention strategies that are beneficial for linking pastoralists to milk markets.

5.1 Introduction

Policy and intervention strategies account for the need for market access in catalysing development (Roba et al., 2017; Sinja et al., 2006). As such, many governments, especially in developing countries, appreciate the private sector's role in contributing toward rural development (Schoneveld, 2020). However, producers' market access often remains a challenge, especially for pastoral households selling milk (Mccabe et al., 2010). Pastoralism is an extensive livestock production system, highly adapted to high variability in climatic and environmental conditions. It is dependent on mobility for cattle to utilise nutrients across heterogeneous landscapes (Nori, 2019; Simula et al., 2021). There are many complexities in linking this mode of production to the market. To try and address this, government policies and interventions aim to promote sedentarisation efforts in rangelands (Anderson, 2010). However, such policies do not respect the mobile cultures of pastoral communities nor the environmental logic that underpins them (Anderson, 2010; Mdoe and Mnenwa, 2007). Although this narrative is continuously being challenged (Hallo Dabasso et al., 2021), creating and enabling alternative strategies that link pastoralists to milk markets without radically changing their production systems is difficult.

This means the methods for linking pastoralists to milk markets are not self-evident – it is difficult to sell and buy a moving product, especially from households that are often on the move. Traders engaging pastoralists in milk markets are thus faced with a variety of challenges**.** First, the availability of marketable (surplus) milk in pastoral households is highly variable across seasons, with lower milk volumes during the dry season due to feed shortages and cattle migration in search of feed (Mccabe et al., 2010; Sadler et al., 2010). This affects sourcing structures, making it risky for traders and processors, who need a consistent and ample milk supply at a steady price. Second, customarily, pastoralists have kept their cattle for subsistence milk production and as a store of wealth, meaning they are keener to maintain livestock breeds that are more adaptable to the ever-changing environment, rather than increasing their productivity (Krätli and Provenza, 2020). This, coupled with pastoralists' high mobility, decreases the stability of available milk for buyers. Third, sourcing milk from pastoral households is marked by high transaction costs (Leonard et al., 2016). This is because pastoralists rarely bulk milk with others, partly due to their mobility and large herd sizes. Marketing strategies for pastoralists, therefore, must overcome these challenges, along with those presented by changing seasons and agroecological conditions.

Previous studies have provided valuable information on pastoralists' market connections, but there is still some gap, especially in understanding the agency of business actors in enhancing market linkages for pastoralists' milk marketing. For instance, strategies for linking pastoralists to milk markets are either non-existent or based on the processor-driven organisation of milk value chains and farmer-led cooperatives and do not consider the particularities of dryland livestock production systems (Makoni et al., 2014; Nell et al., 2014). Such systems allow for easier coordination and lower transaction costs in sourcing milk. However, such strategies have often failed because they present a mismatch between local pastoralists' production practices and the milk marketing system's needs. Previous research into pastoralists' practices for increasing participation in livestock marketing has focused on increasing live animal sales (Barrett et al., 2004; Roba et al., 2017), the profitability of pastoral milk marketing (Leonard et al., 2016) and camel milk marketing (Noor et al., 2013). These studies have tended to ignore the agency of business actors and how the business practice works and leads to inclusive economic engagement. Without understanding local socio-cultural contexts, lead firms and farmer cooperatives based on rigid marketing structures risk exacerbating societal inequalities and the exclusion of marginalised producers (Schaltegger et al., 2016). We consider it of specific importance to understand better the agency of business actors in enhancing the engagement of pastoralists in milk markets.

The objective of the study is to assess why certain business practices of milk traders and collectors have been successful in connecting with pastoralists. We make an empirical contribution to identifying conditions in everyday business realities that make this connection viable. In doing so, we analyse business practices in dryland Tanzania that achieve alignment between pastoralists' production practices and local traders' milk sourcing practices. Specifically, we start by analysing a lead firm's failure due to rigid, predetermined milk sourcing practices. We then move on to examine subsequent milk sourcing by independent traders in the same area that has succeeded in engaging pastoralists in milk marketing. Using a case study approach, we analyse the relationships between producers and commercial buyers through the lens of alignment. Analysing alignment as a suite of practices highlights how traders engage in sophisticated and flexible market development to address producers' needs and challenges, thus enabling their inclusion in market processes (Schouten et al., 2016). In this case study, we specifically examine the traders' business practices by focusing on how markets self-organise and function to ensure a consistent flow of milk. By looking at everyday practices, we offer insight into the choices of traders operating within dynamic

social structures and natural environments that ensure the inclusive economic engagement of pastoralists, which may also stimulate responsiveness in shaping socio-technical changes at the level of pastoralist producers.

We use a methodological approach that analyses traders' day-to-day business practices, which constitute the alignment of pastoral livestock keepers and commercial milk traders. We use a practice-based analysis to assess the interactions between human activities within dynamic natural dimensions (e.g., seasonal changes affecting feed and in turn, milk volumes), which in turn shapes milk production. This highlights the complex relationships between the natural environment and human activities of production, which in turn shape business practices. In this context, we focus on the commensurability of traders' and producers' practices, each with their distinct logic, connected to the everyday business practice of sourcing milk across time and space. This includes establishing and maintaining compound relationships, unwritten rules and norms, task distribution and daily milk collection routines while being flexible enough to allow for improvisation. The practice approach helps us to understand how everyday decisions are made in response to the varying production practices by transhumant pastoralists. In addition, the practice approach helps us to unravel why the strategies employed by the independent traders worked and the properties that can be attributed to the success of the traders. By using a practice approach, our analysis aims to demonstrate how economic organisation emerges, not as an outcome of intentional system design, but through decentralised processes and actions of solving dynamic everyday problems. We complement the inclusive business literature (Schaltegger et al., 2016; Schoneveld, 2020) by adding the importance of flexible processes and improvisation actions for solving everyday problems.

This paper proceeds as follows: Section 2 describes the research methodology, which includes a review of the practice approach to understanding business practice. Next, we introduce the case study by explaining our data collection and data analysis process. The subsequent results section presents findings on the emergence of innovative business practices in milk sourcing for pastoral households. The discussion focuses on the logic that allows business practices to enhance inclusivity and implications for development. Finally, the conclusion highlights the main messages and suggestions for policy and development practitioners, as well as future research directions for milk sourcing.

5.2 Research design

5.2.1 Methodology

We draw on the practice approach by Nicolini (2012), who argues that "practices are meaning-making, identify-forming and order-producing activities. They institutionalise activities and ways of doing through repetition" (Nicolini, 2012, p. 7). In this context, "order-producing" means that practice is where business actions are shaped and reinforced. Using practice framing provides an analytical approach that highlights how economic and social outcomes are shaped by everyday activities and actions performed by actors to create an everyday economy (Mangnus and Vellema, 2019). Practices have a *subject* (the actor); they also have an *object* that is transformed into an *outcome* by performing a practice (Nicolini, 2012). Therefore, in this study, we look at how a group of traders (the subject) in Dakawa, Tanzania, organises the sourcing of milk (the object) by including pastoral households in milk selling (the outcome). We propose that this represents a novel business practice from which we can learn about mechanisms of inclusion.

To study the alignment of business and pastoral producers' practices as an evolving social relationship in a dynamic context, we review various literature on institutional diagnostics – focused on the need to identify context before acting (Rodrik, 2010) – and the application of contextualised diagnostics of institutions in food systems (Schouten et al., 2018). From these studies, we borrow two key concepts that shape alignment. First, we examine the establishment of institutions that enable rule-setting in business practice that facilitates engagement between traders, intermediaries, and producers. In this study, we analyse traders' business choices, engaging intermediaries, and the role of trust in ensuring economic engagement. Accounting for local production practices and variability is key to developing marketing systems that are responsive to local needs (Aspers, 2007; Schoonhoven-Speijer and Vellema, 2020). Second, we examined processes of self-reinforcement of the viable institutions that support business practices in sourcing milk (Schouten et al., 2018). Drawing on these two concepts, alignment reflects the interactions between traders and pastoralists within a set of locally embedded practices, rules and norms that are both economic and social (Beer et al., 2005; Vellema et al., 2020).

The analysis presented in this study is organised around three dimensions of the dairy business in the study site. First, we analysed how traders and milk companies strategise and make choices to source milk from pastoralists in ways that meet the interests and needs of both parties. This starts

with a chronology of previous, abandoned arrangements by lead firms and then details of traders' current practices. Here, we focused specifically on how rule-setting and self-enforcement practices happen across the various intermediaries. Second, we examined how traders and transporters navigate structural factors (e.g., ecological seasonality, mobility, poor road conditions) in their milk sourcing practices. Third, because practices are mutually constitutive and continually evolving, we analysed how pastoralists change their production practices in response to traders' new alignment practices. Engagement in milk selling requires a restructuring of practices at the production level, as well as shifts in norms and roles. We specified what these practices are and what they mean for the pastoralist communities.

5.2.2 Research context

In Tanzania, 70% of the total national milk production comes from pastoral and semi-intensive systems (Michael et al., 2018). Approximately 50% of households keep livestock, which supports 27 million people. Despite the contribution of pastoralists to the national economy, the mobility of pastoralists is increasingly challenged, and many policymakers, either knowingly or unintentionally, promote policies of sedentarisation (Davies and Hatfield, 2007). For instance, the government policy on Ujamaa in 1975 and villagisation profoundly affected pastoral land, as pastoralists were forced to move into "planned villages" (Bee et al., 2002). More recently, the livestock identification, recording and traceability systems implemented in Tanzania between 2016 and 2018 have caused a sharp decline in cattle mobility between districts and, in some instances within districts, they have further contributed to a decline in pastoral mobility {Formatting Citation}. Besides the national policies, villages – dominated by farmers – have implemented by-laws restricting herders' movements from one village to another, and these are monitored by village councils (Sule and Mkama, 2019).

5.2.3 The case study: milk selling in Dakawa ward

This research used a case study approach conducted in the Dakawa ward within the Mvomero district in the Morogoro region of Tanzania. A case study approach allows for an in-depth, intensive study of a bounded phenomenon (Gerring, 2004). The phenomenon of study, in this case, is the practice of alignment of traders' and pastoralists' practices in milk selling. The detailed description of the business setting, actors, processes and interactions (Vellema et al., 2013) lead to alignment. This case study allows us to study context-specific practices that shape alignment, and

it provides insight into the complex and dynamic interactions that demonstrate how economic action evolves. This case study is particularly interesting because it evolved as a response to the producer's need to sell milk without the involvement of the government or any other development organisation.

Dakawa was selected due to the high concentration of pastoral households selling milk and the availability of milk traders operating cooling centres. Dakawa is a big roadside village, inhabited by both pastoralists and farmers (Mung'ong'o and Mwamfupe, 2003). It is located along Morogoro-Dodoma Road. Morogoro is only 47 km from Dakawa, with a good quality tarmac road linking the two towns. The urban population in Morogoro and crop farming households in Dakawa provide a good market for milk from Dakawa. Morogoro also provides a link to Dar es Salaam, the country's business city, approximately 185 km from Dakawa. Urban consumers and large milk processors in Dar es Salaam provide an additional milk market. Dakawa has fertile soil for farming, and the Wami River is used to irrigate rice. Dakawa is home to large commercial farms, including the 2,000 ha Dakawa Rice Farm (Mdee et al., 2014) and commercial ranches (e.g., the Catholic-owned TEC Dakawa and the Shamba Kubwa ranch). The pastoral communities within Dakawa are transhumant Maasais.

5.2.4 Methods for data collection and analysis

Data were collected using qualitative and quantitative methods and direct observation. The initial quantitative study was conducted in 2018. At the same time, the second step of the study, with a total of 17 qualitative interviews, was conducted in 2020 across four months (May-August). First, in-depth key informant interviews were organised to understand the history and changes in pastoralists' milk marketing in Dakawa. Key informant interviews were conducted with all the traders/cooling centres (5) in Dakawa, motorbike milk aggregators (4) who aggregated milk from households and pastoralists (7) and the local government representative. The questions for motorbike milk aggregators were based on everyday activities on milk sourcing, including milk quality tests, aggregation, and transportation. The questions for milk traders focused on how they navigated seasonal variability and variability in milk prices and volumes to ensure a steady flow of milk from production to the end market.

Second, trade practices were observed across the four milk cooling centres. Observations were also made to understand the practices concerning milk collection, cooling, and bulking, as well as

interactions with other traders, motorbike milk aggregators and pastoralists. The observations made here deepened and expanded the data collected during qualitative interviews. Key informant interviews with pastoralists, both men and women, were held independently to assess their responsiveness to the milk sourcing strategies employed. In addition to this, a focus group discussion with men from the district was arranged to gain an understanding of the changes in the practice of milk production and milk marketing.

This was also augmented by a household survey conducted in June 2018. The household survey was conducted among 60 pastoralist households in Dakawa. The survey followed a representative, random sampling strategy among pastoralists and aimed to capture pastoralists' production systems, practices, breeds and if and where they sell milk. A richer analysis of the survey has been published elsewhere (Kihoro et al., 2021) but, here, the household survey data is used to show the proportion of pastoralists selling milk and the main differences between pastoralists selling milk and those who are not, in terms of breed composition and income from dairy (see Table 5.2).

Data from the qualitative interviews were transcribed and translated from Kiswahili to English. All the audio interviews with a length of 892 minutes were transcribed into text documents using Atlas-ti 8. A thematic analysis was used based on both inductive and deductive coding. From the coding exercise, 78 codes and 8,746 quotations emerged. The output was synthesised into the three broad themes as noted above: (i) Businesses navigating, (ii) The practice of alignment between traders and producers, and (iii) Mapping the responsiveness of pastoralists to the current milk business practices (See Table 5.1below).

The presentation of results is organised according to the analytical framework presented above. We start by providing a chronology of milk sourcing strategies in Dakawa. This is followed by the presentation of the case of alignment between producers and traders by tracing motorbike milk aggregators' practices for sourcing milk and traders' practices for navigating the milk markets. Finally, the responsiveness of the Maasai toward the sourcing strategies is mapped. The discussion section synthesises these three aspects to highlight how traders' and motorbike milk aggregators' skilful performance of improvised business practices has developed an innovative endogenous commercial dairy system built upon the realities of pastoral milk production. The discussion ends by outlining the implications of this analysis for inclusive rural development.

Table 5.1. Analytical framework

Dimension	Indicators/code groups	Codes
Businesses navigating the sequence of instructive events in Dakawa	a) Lead firm milk sourcing practices	Processors and agency model
	b) Traders' milk sourcing practices	Multiple traders Coordination
The practice of milk collection by independent milk traders	a) Navigating seasonal variability in prices and volumes through selling to different buyers	(Multiple buyers) Milk buyers Milk market seasonality Cattle movement
	b) Adapting to pastoralists' movement strategies	Price setting Milk collections (volumes and suppliers)
(ii). Tracing motorbike milk aggregators' practices in sourcing milk	a) Organising milk collection b) Coordination across time and space	Operations milk collection Quality test Aggregation Transportation Coordinating payment Competition Challenges Strategies
Responsiveness of pastoralists to the current milk business model.	a) Gender roles b) New livelihood opportunities c) Changes in pastoral practices	Sedentarisation, farming Changes in pastoralism Household milk utilisation Grazing land Feeding Breeds Decision making Gender roles Milking Cultural aspects

5.3 Results

This section provides a chronological sequence of instructive milk sourcing events and highlights aspects that caused previous milk collection practices by leading firms to fail. We then provide a descriptive account of independent traders' milk sourcing practices that align with pastoralist production practices. Here we focus on how traders coordinate across time and space, how they navigate seasonal variability in milk volumes and prices, and how they coordinate with motorbike milk aggregators to aggregate milk and make timely milk payments to producers. Finally, the results section explores the responsiveness of pastoralists to new market arrangements in terms of gender roles and changes in production practices.

5.3.1 The practice of milk collection by lead firms

The first processor to set up a cooling centre in Dakawa was Tan Dairies in 2007[10]. Tan Dairies sourced milk directly from pastoralists without involving intermediaries. The establishment of the collection centre was a relief to many Maasai women who would otherwise carry the milk using traditional gourds, to sell either to their immediate neighbours or to urban consumers 45 km away in Morogoro town. During the wet season, Tan Dairies were able to sensitise pastoralists and receive sufficient milk volumes. However, achieving adequate milk volumes during the dry season was difficult. This was because most pastoralists would move away in search of pasture, reducing the milk supply, which would lead to higher milk prices due to the constrained supply. In 2017, the company stopped operations in the region due to a lack of adequate milk volumes.

> *"Our biggest challenge then was to ensure a constant milk supply to the factory. The factory does not regard whether it is wet or dry season, milk is supposed to be constantly supplied all the time. That was the most challenging task for me"*. Former Tan Dairies employee 29/05/2020.

Tanga Fresh Ltd. Company began collecting milk in Dakawa in 2011. Tanga Fresh Ltd. applied an agent-based model where an individual was tasked to coordinate milk collection. Tanga Fresh Ltd. catered for the operational costs of the cooling centre and paid the staff. This model worked for four years. Through their staff, Tanga fresh sensitised Maasai women on the need to sell milk. Unlike Tan Dairies, Tanga Fresh Ltd. engaged milk motorbike milk aggregators in milk collection. At that time, the motorbike milk aggregators (intermediaries) only sourced milk for Tanga Fresh Ltd. However, from 2014 onwards, other independent traders opened cooling centres. As the number of other traders increased, two aspects affected the milk collection. First, during the dry season, the Tanga Fresh Ltd. Cooling centre was not aggregating enough milk due to higher competition. Second, higher milk prices made it difficult for Tanga Fresh Ltd. to compete with independent traders.

[10] Tan Dairies Ltd is a Private Tanzanian Company that process milk products, natural juice, and honey. The Company was established in 2000. It has successfully developed the DESA® brand of dairy products, which is unique because of the natural flavour of milk from local cows grazed on natural pastures.

"Milk collection centres started increasing. During that time other cooling centres emerged. Milk traders increased drastically. This led to price fluctuations. The traders came with high prices and increased competition". Former Tanga Fresh Ltd. employee 28/06/2020

With additional traders sourcing milk from the area and the seasonal fluctuations in milk volumes and prices, Tanga Fresh Ltd. was unable to secure a consistent flow of milk, especially during the dry season, and the cooling centre closed in 2015.

5.3.2 The practice of milk collection by independent traders

The process of market navigation was done differently by a network of traders who sought to align with pastoralists' production needs. In the following section, we highlight everyday practices through which the relation of milk producers (Maasai women), milk collectors (motorbike milk aggregators) and traders (cooling centre owners) results in a selection of processes that leads to an alignment of milk producers and traders' goals. The results are presented according to three sub-themes: (i) traders navigating the milk markets by adapting to pastoralists' movement strategies and navigating milk volumes and price variability across seasons; (ii) tracing motorbike milk aggregators' practices in sourcing milk, including organising milk collection, quality control and bulking, and (iii) coordination across time and space.

Traders navigating the milk markets

Traders in this study are independent investors who aggregate, chill and sell milk to external buyers (e.g., retailers). Traders own milk cooling equipment, and they aggregate between 500 and 4,000 litres of milk per day. All the traders were individual Swahili (non-Maasai) intermediaries – according to the Maasai culture, Maasai men do not engage in the milk trade. Traders require initial capital to buy cooling tanks (1,500–5,000L cooling capacity) and enough money to pay producers and staff. The traders also navigated the seasonal variability affecting milk volumes and prices in Dakawa to deliver milk to retailers and consumers in Morogoro (47 km from Dakawa) or Dar es Salaam (185 km from Dakawa). All the traders and employees working at the cooling centres had a career history in milk collection. As such, the cooling centres were operated by people who already understood the contextual dynamics of milk production and marketing. The individual ownership of cooling centres, as opposed to the more complex ownership and management structures of processor companies, provided a relevant distinction in terms of companies' ability to engage in new business models.

During the dry season (July, August and September), milk volumes decreased across all collection centres (see Figure 5.1) because of reduced feed availability. Therefore, pastoralists, motorbike milk aggregators and traders navigated variability in volumes across seasons. All traders received an average of 1,000L less milk per day in the dry season compared to the wet season. Milk traders addressed this challenge by selling a higher proportion of milk to retailers in urban markets in Morogoro and Dar es Salaam because they purchased milk at a higher price per litre (1,000–1,200TZS). During the wet season, a higher proportion of milk was sold to private processing companies because volumes were higher, and prices were lower (700–800TZS) (see Figure 5.2). In Dakawa, only smaller processors specialised in value-added products, such as yoghurt and collected milk at a higher price (800–1,000TZS.

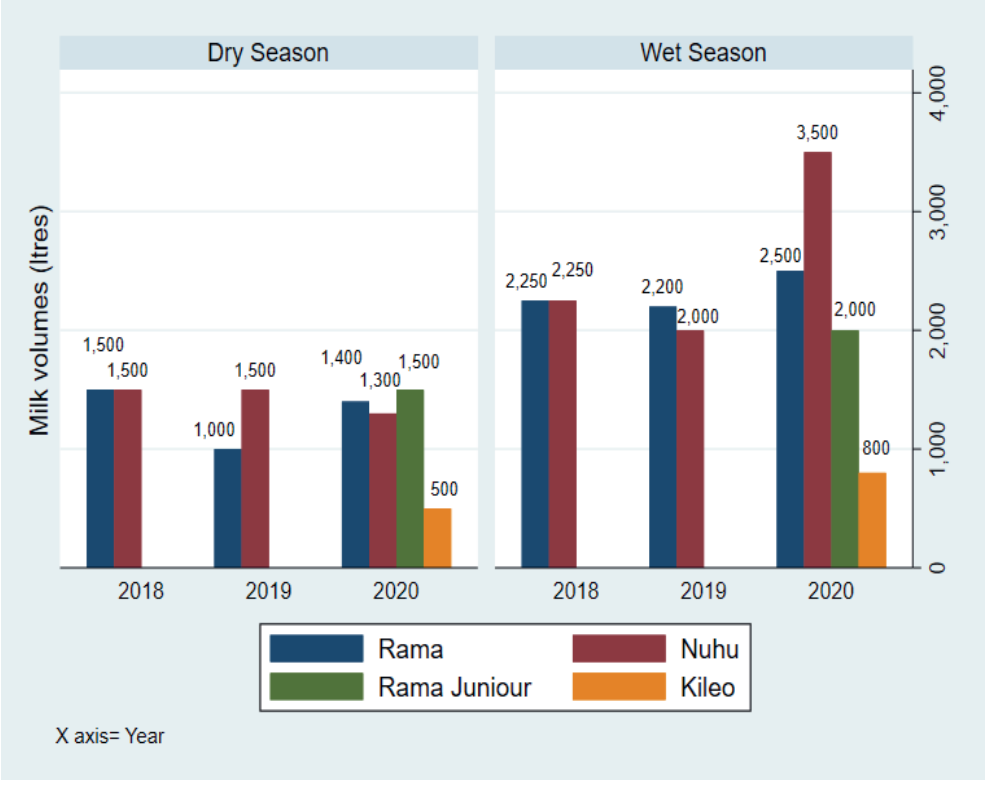

Figure 5.1. Average milk collection across the season and cooling centres

Source: own survey 2020

In 2020, the dry season milk prices were lower than in previous years (Figure 5.2). This was due to reduced milk consumption, attributed to COVID-19 disruption in milk transportation to urban markets like Dar es Salaam.

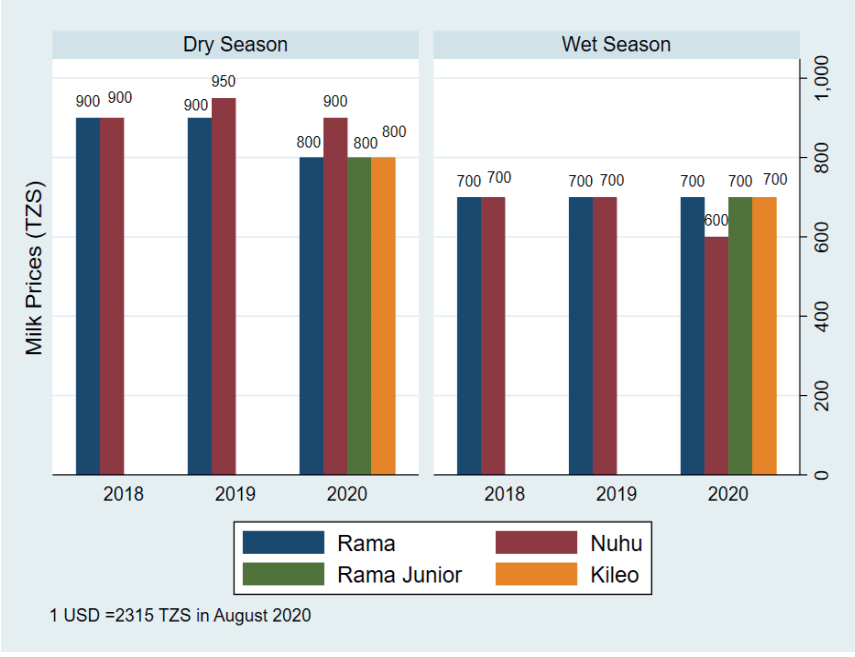

Figure 5.2. Prices of milk across seasons and cooling centres
Source: own survey, (2020)

Coordination between traders

The level of competition and collaboration between traders varied depending on the need and season. Traders used price setting and reliability in milk payment as a strategy to attract motorbike milk aggregators. Price setting was done by word of mouth, and it changed in response to seasonal variability and milk volumes. During the dry season, traders who offered the most competitive prices received higher milk volumes. Prompt milk payment was also pivotal in getting a consistent milk supply and new referrals. Traders who paid on time gained loyalty from motorbike milk aggregators and consequently the pastoralists who supplied milk to the motorbike milk aggregators.

> *"There are two stages involved in price setting. Motorbike milk aggregators – respond to a communication from individual pastoralists – lobby collection centres to increase milk prices. This change is based on the onset of dry and wet seasons. Suppose the price at the collection centre has increased to 800 TZS, the motorbike milk aggregator would inform the Maasai women supplying them with milk".* FGD respondent 29/05/2020.

Traders also collaborated for convenience. For example, if a trader had a large order that they were not able to fulfil, they could request additional milk from their peers. Also, in case of equipment malfunction (e.g., cooling facilities), they could request other traders to chill milk on their behalf at a small cost. This collaboration was a way of navigating market-related risks.

iii) Tracing motorbike milk aggregators' practices in sourcing milk

The network of traders cannot exist without the network of motorbike milk aggregators. They aggregate milk from Maasai households and deliver it to cooling centres. Motorbikes were the preferred mode of transport due to their versatility in poor infrastructure and low fuel consumption. Young (male) motorbike milk aggregators (20-25 years old) identified several pastoralists' households from whom they collected milk. The initial engagement was done through referrals from other pastoralists or motorbike milk aggregators. The relationship between motorbike milk aggregators and pastoralist women was based on the trust established through reliable and prompt milk payments and accurate milk volume capture. There was no formal agreement or contract between the motorbike milk aggregators and pastoralist households supplying milk. Milk collection was made between 6.00, and 9.00 am. The early morning was preferred because temperatures were lower (which reduces the risk of milk spoilage), and the women could milk the cows before they were taken out for grazing. In each household, the motorbike milk aggregators performed a milk quality test using a lactometer and an alcohol test, and they recorded the milk volumes using a measuring cup. The milk was aggregated in 100 litre aluminium cans or several 20 litre plastic cans for transportation to the cooling centre. Motorbike milk aggregators collected an average of 100–220L per day.

Once the milk was aggregated from several households, it was either delivered to one of the cooling/trading centres or divided among two or three centres. Motorbike milk aggregators delivered milk to multiple cooling centres to maintain diverse commercial networks and guard against market risks. The motorbike milk aggregators did not have any contractual agreements

with the cooling centres, and trade was done based on trust. The motorbike milk aggregators got a markup per litre of milk transported. On average, the markup was between 100 and 200 TZS per litre of milk, depending on the distance covered and season. Cooling centres paid motorbike milk aggregators who, in turn, paid the Maasai women at their homes. This strategy was preferred by the Maasai women over the previous processor-based model, where women were required to collect their payments from the cooling centres. Some cooling centres paid the motorbike milk aggregators daily, who in turn paid farmers daily. Others paid after ten days, and others after two weeks. However, most centres had a diverse range of payment strategies depending on the pastoralists' needs. In case a household had an emergency and needed money before the agreed period, the cooling centres advanced the motorbike aggregators the money, who would, in turn, pay the pastoral households on behalf of the cooling centres.

> *"We are paid after ten days; however, it goes up to 15 or 16 days. In case the payments delay until the food is finished, one can ask for advance payment. Also, if I need money for the hospital, suppose my child is sick, they can give me money* before *the payment date. However, the advance can only be cash equivalent to half the milk I have delivered at the point of request"*. A woman pastoralist in Dakawa 5/06/2020

The practice of motorbike milk aggregators aggregating milk from individual households made it more attractive for pastoralists to sell milk. This was because the women no longer needed to travel long distances in search of milk buyers. In addition, the flexibility in terms of payment methods and the ability for the producers to get advance payments in case of emergencies marked the relationship between traders and producers more interactive. The motorbike milk aggregators' flexibility in choosing which cooling centres to deliver milk to, cushioned them against market shocks (e.g., milk spoilage from one cooling centre resulting in losses or delayed payments from traders).

iii) Coordination across time and space

Milk trading involved several tasks performed by different people across seasons and locations. During the dry season, pastoralists moved their cattle from Dakawa to Dumila (50 km from Dakawa) and other neighbouring areas, such as Mgudeni (30 km from Dakawa). During the wet season, most of the cattle grazed near Dakawa; hence milk was collected and transported to cooling centres in Dakawa (Figure 5.3). However, in the dry season, most cattle were moved to Dumila

and other areas. Two traders had established additional collection and cooling centres in Dumila to boost dry season milk collection in Dumila and its surrounding environments. Therefore, during the dry season, cooling centres in both locations were operational. The two towns were linked with a good quality tarmac road, so traders could transport milk between the two centres at minimal transport cost.

The pastoralists coordinated with motorbike milk aggregators to notify them about their movement patterns. Approximately 40% of the motorbike milk aggregators were Maasai men, so they were aware of the pastoralist movement patterns. Usually, they would move with their households (lower living costs) and collect milk from their households and other households around them. The motorbike milk aggregators who were not Maasai relied on communication with the households from whom they collected milk and could not travel far (more than 30 km) from their households to avoid incurring higher living and transport costs. When motorbike milk aggregators did not see the economic value of moving with pastoralist households, they dropped out of the milk business until the wet season, when the households returned to Dakawa Ward. Under such circumstances, motorbike milk aggregators coordinated and notify each other which households were covered to avoid overcrowding one area.

> *"Pastoralists inform me that they will shift to other areas at a certain time. So, it is my duty now to see whether I can manage to collect from where they moved to otherwise, I must wait until the wet season. Because sometimes they move far from Dakawa, and the road network is poor"*. – Motorbike milk aggregator 06/07/2020.

There was a high level of coordination between motorbike milk aggregators and traders to ensure that required milk volumes were obtained. Take, for instance, Rama who noted, "I receive calls from buyers the previous evening notifying me of the volumes needed, I then call my motorbike milk aggregators to request for specific milk volumes from each according to my order." The advanced communication helped the motorbike milk aggregators to know where they would be delivering milk in the morning. Therefore, the day-to-day practices of sourcing milk were based on spontaneous problem-solving, and improvisation embedded in the community and geography.

All the traders cited trust as the main component facilitating the milk transactions between pastoralists and motorbike milk aggregators and between aggregators and traders. Therefore, the aggregators established a milk supply network – cultivated through prompt payments,

responsiveness to the pastoralist needs, and accuracy in milk payment. One trader noted that trust, effective communication, understanding people's problems and the ability to solve problems were the main pillars of their business. Trust was also leveraged as a basis of competition.

> *"I started selling milk to a Swahili motorbike milk aggregator. He ran away with my money. Later I got engaged with another Swahili motorbike milk aggregator who is trustworthy and up to date. I have only one motorbike milk aggregator currently, and I or any of my friends can never sell to those who previously ran away".* A woman pastoralist in Dakawa 5/06/2020

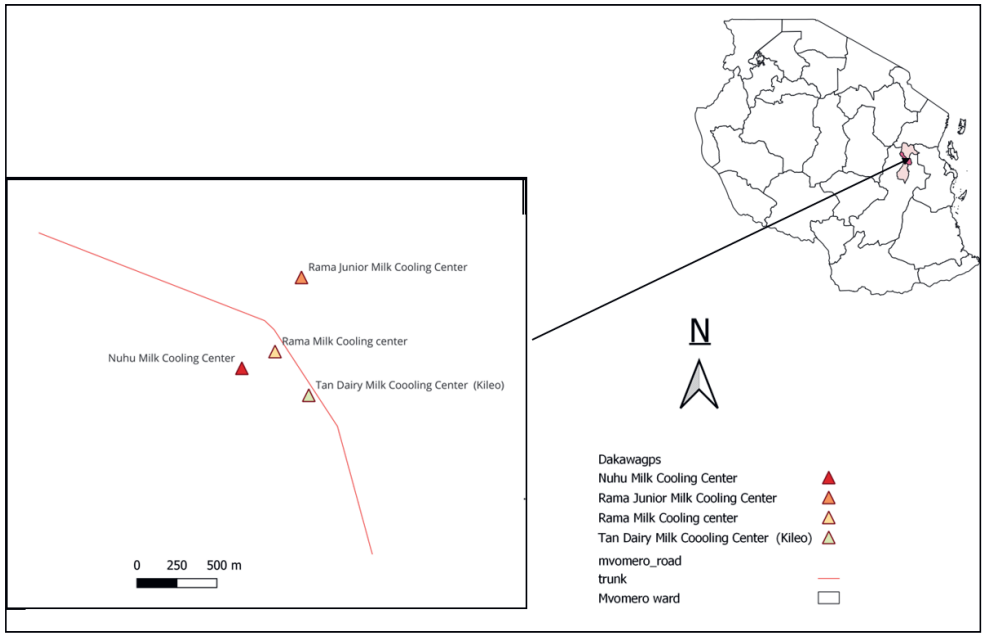

Figure 5.3. Milk cooling centres in Dakawa ward

Traders who did not honour their word in terms of adhering to the set milk prices or milk payment timelines did not receive milk from the motorbike milk aggregators. Similarly, motorbike milk aggregators who delayed pastoralists' payments did not get milk. Alignment was constructed in business practice constituting improvisation and flexibility as things unfolded. Central to their success was building on the motorbike milk aggregators' network and innovative navigation of milk sourcing and selling across seasons.

5.3.3 Responsiveness of pastoralists

Alignment was not a simple fix and required a transformation both from the traders' and pastoralists' practices. We specifically analysed how pastoralist communities were changing in response to the new model of commercial dairying. The change was highlighted based on three aspects: gender roles, new livelihood opportunities and production practices. According to the Maasai culture, men own the cattle, and the milk was managed by women. Women noted that the Maasai men in Dakawa were now more appreciative of milk selling upon seeing the benefits of milk sales. Previously, men prohibited women from selling milk, and they preferred the milk to be used either for home consumption or left for calves.

> *"Sometimes husbands restricted selling milk and insisted on reserving milk from the cows for calves. The man is the main decision-maker in the household. Only the man can allow you to access the household. But the business will be conducted by a woman".* Male FGD respondent 29/05/2020

Although gender roles in the Maasai community were still clear-cut, women were tasked with milking and selling milk, while the men were responsible for the general welfare of the cattle. Women noted that the milk business enabled them to invest and help with the provision of money to cater for some basic animal health-related costs. Previously, men would have to sell a goat to cater for animal health and other household expenses, but now this can be catered for using the revenues from milk. "The man must sell a goat to get money. He can only earn 50,000 TZS if selling a goat, while a woman in ten days has 900,000 TZS from milk sales. This could change the culture". Trader 28/06/2020.

Another changing gender role was the involvement of young Maasai men in the transportation of milk, which had previously been the domain of non-Maasai men. The young men aggregated and transported milk from their households and from other nearby households to traders. This represented a new opportunity for livelihood diversification. The involvement of Maasai men was a crucial element of the new business model, especially during the dry season. Because they were socially and culturally embedded, they could effectively connect producers and traders, blending the skilful management of pastoralist movement practices and markets.

Traders created a technical, cultural fit that had implications on how herds were managed. Table 5.2 shows the characteristics of the surveyed pastoralist households in Dakawa. On average, 50%

of the households interviewed sold milk. There was no significant difference between households that were selling milk and households not selling milk in terms of herd size and amount of land owned. However, 45% of the households selling milk kept a crossbreed cow, and their average milk production was higher in both dry and wet seasons (19.05L/day) compared to non-selling households (8.27L/day).

Over time, households saw the benefit of having a few crossbred cows to enhance milk production. The households taking up crossbreds often crossed the local Zebu with Ayrshire. Ayrshire was preferred for its higher milk production and its relative adaptability to heat and disease stress. However, pastoralists kept large herds of cattle in line with their cultural customs. Respondents noted, however, that keeping many exotic dairy cattle required additional land for grazing because crossbred cattle need high feed inputs to produce high milk outputs, and they were not admirably adapted to mobility. However, expanding grazing lands was out of reach for most pastoralists because the private land acquisition was capital-intensive and unaffordable to most. This denotes existing structural constraints hindering milk commercialisation within pastoral systems.

Table 5.2. Differences in demographics for pastoralists selling milk and those not selling milk

	Selling milk (n=31)	**Not selling milk (n=31)**	**Total (n=62)**
Variables	**Mean (sd)**	**Mean (sd)**	**Mean**
Total livestock numbers [no.]	56.23 (55.83)	49.23 (48.18)	52.73(51.84)
Number of cows [no.]	20.58 (17.85)	19.23 (22.02)	19.90 (19.89)
Whether household keeps crossbred cow [%]	**0.45 (0.51)**	**0.13 (0.34)**	0.29 (0.46)
Average milk wet season per household [litres]	**19.05 (22.02)**	**8.27 (8.86)**	13.66 (17.51)
Average milk dry season per household	**12.70 (16.80)**	**5.27 (8.47)**	8.99 (13.72)
Land acres	8.43 (7.72)	7.37 (9.13)	7.88 (8.40)
Experience selling milk [Years]	**11.90 (8.70)**		11.90 (8.70)
Annual milk revenue [TZS]	**2,248,500 (2,785,065)**		2,248,500 (2,785,065)

Source: Own survey June 2018

5.4 Discussion

This study analysed the agency of business actors in creating viable market links with pastoralists. The results highlight why marketing strategies used by lead firms failed and what enabled networks of independent traders to succeed in engaging transhumant pastoralist households in commercial milk marketing. We define this as alignment capacity, building on the work by (Beer et al., 2005; Vellema et al., 2020). Alignment capacity, as a term borrowed from business literature,

is defined as the "alignment of organisational capabilities with competitive strategies in the constantly changing circumstances of the business environment" (Vellema et al., 2020, p. 716). To achieve alignment capacity, business practices and performance need to align with producers' practices within their specific socio and agroecological context. Literature on alignment specifies two types of alignment: internal within the business and external, denoting the business environment (Beer et al., 2005). Both types of alignment were present in the practice of milk trading, as described in the previous section.

Internal alignment denotes how economic actors modify their businesses and include new practices and decision-making structures (Beer et al., 2005). The case study demonstrated that traders mobilised certain skills for sourcing milk from pastoralists: this included the ability to co-create terms of inclusion that fit pastoralists' logic; the everyday decisions made by traders to solve everyday problems; for instance, the decision taken by traders to overcome changing milk volumes and milk prices by changing milk buyers across seasons, constant communication with intermediaries; flexible payment of pastoralists and the use of unwritten norms and processes that become institutionalised to form an inclusive economic engagement for transhumant pastoralists.

External alignment is based on how the lead agent aligns with the interests of less powerful actors (Vellema et al., 2020). Our study demonstrates how traders work with motorbike milk aggregators to solve challenges associated with milk bulking and seasonality. This was achieved by understanding the institutional process that supports rule-setting to facilitate alignment between traders, intermediaries and pastoralists, and processes of self-reinforcement for the viable institutions that support business practices in sourcing milk.

What enabled the construction of alignment capacity?

Our results show two characteristics of internal alignment used by independent traders. These are; (i) the use of different milk buyers across seasons and (ii) competition and collaboration strategies among traders. Alignment was enabled by traders managing different milk buyers across seasons to smooth over fluctuations in volumes and prices. During the dry season, traders sold milk to retailers in urban centres, who, required lower volumes and could pay higher prices. Proceeds from the sales were passed down to producers in terms of a higher milk price during the dry season. This was beneficial for pastoralists who incurred higher costs while sourcing feed and water during the dry season. This underscores the need for businesses to distribute economic costs and benefits

equitably among the various actors within the chain (Schaltegger et al., 2016). Consequently, linking pastoralists to milk markets means traders need to align business practices with pastoralists' needs, including their modes of production (Nori, 2019), seasonality and high mobility (Simula et al., 2021), incurring high transaction costs in sourcing milk.

Traders employed a mix of competition and collaboration strategies. Traders used higher buying prices to attract higher milk volumes, employed as a competitive strategy. However, traders also collaborated, in supporting each other in case of a technical malfunction from the cooling equipment, or in case they needed to supply large milk quantities. This sort of reciprocal collaboration between competing traders helped to reduce losses and maintain the overall viability of the local dairy sector. Not only have these innovative strategies been institutionalised and professionalised over a few years, but they were also picked up by an increasing number of new traders, which is an indication of their effectiveness. Such strategies are contrary to practices employed by lead firms that operated using competitive strategies with little coordination among lead firms in milk sourcing. This set of actions by traders shows how they react to challenges and opportunities as they arise (Glover, 2018).

The case study shows two external alignment strategies used by the traders, which include: (i) engagement of intermediaries and (ii) sequential coordination across time and space The engagement of intermediaries – in this case, motorbike milk aggregators – in sourcing milk was beneficial in navigating seasonal variability and reduced milk volume during the dry season. Mainstream milk sourcing strategies are typically based on codified, top-down procedures, which do not always align with the local context, culture or milk production systems (Aspers, 2007; Utting, 2015). Two lead firms tried and failed to organise milk sourcing in Dakawa, mainly because of their lack of flexibility to accommodate suppliers' transhumance. Their sourcing strategies focused on excluding intermediaries and formalising relationships with suppliers, (e.g., payments only at specified dates). This rigidity, while effective in other production contexts, precludes flexible practices that help align diary processors' business practices with pastoralists' challenging everyday conditions. These results align with previous works (See Mair and Marti, 2009; Vellema et al., 2020; Zietsma and McKnight, 2009), that note that instead of relying on "institutional ideotypes" alone, it is also important to evaluate provisional institutions that are created and retained as a result of every day problem-solving actions.

Alignment requires sequential coordination between intermediaries and traders. Our analysis of subsequent innovative business practices by smaller-scale entrepreneurs shows that alignment is enabled by the skilful performance of distinct roles in a coordinated manner to facilitate milk sourcing. This includes motorbike milk aggregators navigating milk sourcing across space. The enabling factor for motorbike milk aggregators was either their experience in milk collection and understanding of the local terrain or their embeddedness in the production system. The Maasai motorbike milk aggregators move with the wider pastoralist community; hence they understand the routes followed each season and are embedded in the production systems' practices and networks. Motorbike milk aggregators also have flexible arrangements, meaning they can supply several traders with milk. This flexibility cushions them from market fluctuations and risks. For instance, if one trader wants lower volumes on a given day, the motorbike milk aggregators can sell excess milk to another trader. Coordination is not institutionalised, and traders depend on personal arrangements with motorbike milk aggregators. In the absence of formal contracts, trust and prompt communication play a key role in facilitating trade (Roba et al., 2017).

Responsiveness of pastoralists to alignment capacity

As pastoralists become more integrated into commercial milk markets, their production practices are changing, including the integration of exotic dairy breeds to increase milk productivity. However, they prefer crossbreeds between the local Zebu and exotic Ayrshire for their combination of adaptability to harsh conditions and increased milk production. Recent research shows that pastoralists have consciously engaged in shifting breed preferences to match their livelihood and production system with a changing landscape (Krätli and Provenza, 2020; Scoones et al., 2020a). Their objective is not to optimise milk production under tightly controlled conditions but to maintain resilient milk production under the complex and dynamic socio-economic landscape and environmental conditions (Krätli, 2019; Krätli and Provenza, 2020; Krätli and Schareika, 2010). As such, this flexible market integration allows pastoral households to maintain their livelihood strategy of (limited) transhumance while simultaneously engaging in cultural and technical changes related to emerging market opportunities and their practical knowledge in breed improvement. This provides pastoralists with options for building on their specialisation and expertise in mobility-based production systems rather than disrupting them through sedentarisation and rigid terms of market engagement.

5.5 Conclusion

This study assessed an innovative business practice that engages transhumant pastoralist households in commercial milk marketing, which pushes against conventional wisdom in dairy development throughout Africa. Results show how the failures of rigid business approaches that do not accommodate "non-market" aspects important in the functioning of a market system have paved the way for innovative strategies. While our case study focused on dairy production in a specific site in Tanzania, the analysis has implications for rural development throughout Africa more broadly. Employing a diagnostic lens that highlights what works where and for whom – as defined by contextual factors – our study demonstrates how flexible business practices can succeed by accommodating and complementing existing production practices rather than trying to reshape them to conform to rigid, predetermined formulas. By using the practice approach, we combine observed facts from business practice and see how they translated into existing theoretical knowledge. Using this methodological approach helps us understand business agency in including pastoralists not by a single isolated activity but as an emergent outcome resulting from a series of practices. This suggests that, when rural development interventions are responsive to socio-cultural structures within which economic activities are embedded, they are more responsive to local needs and stand a higher chance of success. These challenges government practitioners to rethink the planning phase of development strategies and to adopt a more diagnostic angle to understand what works for who and in what conditions. Understanding endogenous production and business dynamics and trying to build on existing socio-cultural conditions rather than using pre-conceived strategies lays a foundation for understanding the alignment capacity of traders and pastoralist producers. Instead of reshaping business in terms of how markets should function, this research encourages building on existing structures. In doing so, we demonstrate the importance of the private sector in contributing to sustainable rural development, providing business practice is done right.

Chapter 6

General Discussion

6 General Discussion

6.1 Introduction

The current global agenda for GHG emission reduction has resulted in an increased focus on global policies addressing LED aspects. In sub-Saharan Africa, agriculture is one of the main emitters, with livestock contributing most of the agriculture emissions (Herrero et al., 2016). LED is approached from a technocentric perspective, where farmers adopt best practices to increase production and reduce emission intensities. The technocentric approach views LED as a transfer of technologies considered generic practices, transferable across settings. In Tanzania, the dominant narrative is based on two concepts; intensification (increasing productivity) and commercialisation (selling the surpluses). Commercialisation is often framed in policy as a series of formal transactions. Such a narrow conceptualisation of LED risks mismatches between global LED policy and rural development realities within the dairy sector. This has implications on what solutions are promoted and which actors benefit.

The objective of this study is to assess the local level dynamics within households, business systems and markets in order to anticipate whether and how global level policies on LED can align with local realities. The thesis uses a multi-level approach to evaluate local level dynamics at the farm, business systems and market levels that would help shape the alignment of global LED policies with local realities. I demonstrate that understanding farm-level diversity alone is not sufficient. Different farmer typologies engage with varying business systems and market dynamics where producers must negotiate engagement terms that, in turn, shape LED uptake.

Chapter 2 started at the farm level. It looked at the heterogeneity of households and their differentiated pathways toward the uptake of LED practices. Chapter 3 focused on a comparative analysis between various research sites in two countries. It assessed the interplay between dairy intensification and livelihood diversification, estimated using income, assets, and dietary diversity. Chapter 4 assessed diversity across business systems and their likelihood of enabling LED. Here, I zoomed out from the farm level to focus on institutional and political aspects shaping dairy development at a district level. In Chapter 5, I zoom in on business practices that explain how traders' and intermediaries' agency has shaped the successful engagement of pastoralists in milk

markets. By looking at those three levels, I assessed various constraining and enabling factors shaping the likelihood of LED aligning with local development needs.

This concluding chapter provides a synthesis of aspects to reflect the likelihood of LED practices aligning with local realities across scale. Section 6.2 provides the main findings by presenting answers to the research questions. Section 6.3 reflects on theoretical choices, and Section 6.4 presents reflections on methodological choices. Finally, Section 6.5 provides implications for policy and development, after which I present the conclusion in Section 6.6.

6.2 Main findings: Understanding diversity at multiple levels

6.2.1 Heterogeneity in the uptake of LED practices at the farm level

A detailed analysis of farm-level socio-economic differences and how they are likely to shape LED was the initial inquiry in this thesis. Here, I zoom in on farm-level dynamics by answering the following question: **what are the differentiated pathways for scaling LED that better account for divergent smallholder capabilities, strategies, and interests**? **(Chapter 2).** Socioeconomic factors, including wealth, income, TLU, income diversification and cattle breeds, differentiated respondents and their level of adoption of improved dairy practices. The results showed six distinct types of clusters of producers organised around three production systems: Wealthy and farm-specialist farmers were practising more improved dairy practices (e.g., fodder production, having improved breeds, zero-grazing) and aligned more with intensified dairy production practices.

The findings show that, as currently conceptualised, intensification is not equally accessible or appealing to everyone. Subsistence and marginalised groups were not practising any of the improved management practices except for deworming their livestock which aligned more with extensive production systems. On the other hand, diversified and livestock-dependent farmers moderately adopted these practices and aligned more with semi-intensified dairy production practices. This then challenges the notion that LED can be implemented through a simple technological fix with an expectation of a uniform uptake across the board. Although, in practice, dairy is not organised around LED targets, carefully planning LED strategies guided by local production practices and socio-economic variation provides an opportunity to find a sweet spot between the two goals.

In the next level of inquiry, I evaluated the relationship between dairy intensification and welfare outcomes across households (Chapter 3). This analysis aimed to understand if dairy intensification can lead to the triple wins of increased productivity, welfare gains and higher mitigation gains. This objective was achieved by answering the question; **does dairy intensification drive specialisation and consequently threaten household wellbeing? (Chapter 3)**. I used the three production systems identified in Chapter 2 (intensive, semi-intensive and extensive) to understand the relationship between dairy intensification and livelihood diversification. Contrary to the study's hypothesis (that dairy intensification leads to livelihood specialisation and thus reduces livelihood diversification), the results showed that dairy intensification has a positive correlation with income, assets, and dietary diversity (number of food group types a household consumes). The intensified group had the highest income, dietary, and asset diversity. This could be motivated by the synergistic effects between cropping and livestock keeping (e.g., the use of crop residues as feed and cow manure to fertilise crops), denoting a win-win-win effect, where intensification results in a reduction of emission intensity and positive socio-co-benefits. The semi-intensifying production system had lower income diversity scores than the extensive group. The semi-intensive groups also use less off-farm inputs in dairy production, relying more on grazing their livestock, using crop stovers as feed and minimal external input. Extensive producers ranked lowest in asset and dietary diversity. However, they had higher income diversity scores compared to the semi-intensive group.

While certain households can achieve the "win-win-win" narrative, this is only true under certain conditions and does not apply across the board. Although the LED narrative focuses on dairy intensification, this chapter showed that intensification should be interpreted within the context of other livelihood strategies implemented by households. This is especially true in sub-Saharan Africa, where dairy is part of other livelihood activities on the farm (e.g., crop farming and off-farm business). This means that contrary to early sustainable livelihood literature, intensification and diversification should not always be viewed as distinct livelihood strategies. In specific contexts, intensification and diversification could be mutually reinforcing strategies.

6.2.2 Heterogeneity at the business systems level

In Chapter 4, I zoom out from the farm level to look at heterogeneity across varying business systems by answering the research question: **how do spatially different business systems**

influence the conditions for inclusive low-emission dairy development (Chapter 4)? I used the Business System framework to analyse differences at a sub-national level across four districts in four regions in Tanzania. Results show four different business systems typologies in Tanzania, which allows me to relate that to different production systems distinguished in Chapter 2. The *fragmented business systems* are more commercially driven by lead firms and aligned more with intensified farmers, practising zero grazing, having improved breeds and high eternal input use. The lead firm approach is instrumental in providing farmers with inputs and training through the farmer cooperatives. The farmer cooperatives are also instrumental in enhancing collective action in sourcing inputs and bulking milk to transport to the milk collection centres. *Coordinated business systems* are largely supported by government and donor organisations; they are conducive for a less developed dairy sector, and the close collaboration helps improve farmers' capacity for intensification. However, without proper leadership structures, it is prone to elite capture. C*losed business systems* are milk deficient; producers fetch higher milk prices by selling to individual consumers. This is more amenable to semi-intensive producers where dairy is not their primary income source. C*ollaborative artisanal business systems* were more amenable to extensive producers. Characterised by low input use and high mobility, producers' traders must adapt to varying milk prices and milk volumes.

These findings demonstrate that local business systems are distinct and conditioned by local institutions' realities. Some business systems are not amenable to the mainstream intensification and commercialisation approaches central to the dominant LED narrative. Such business systems risk being overlooked by prevailing national intensification and commercialisation strategies. This is more apparent in informal marketing systems where farmers sell to individual consumers or intermediaries. Informal milk marketing is more prevalent (97.6%) in Tanzania and is motivated by immediate payments, lower transaction costs, transport, and higher prices. The policy implications for these systems are rapidly pushing them into formalised commercialisation pathways, ignoring the intrinsic value of the informal sector, which disrupts existing economic networks that are responsive to the existing institution and agroecological conditions.

6.2.3 Heterogeneity in business practice at market level

Chapter 5 assessed the specific conditions that help ensure unique groups of producers – especially those not motivated to intensify dairy production – are included in milk markets. Therefore, I sought to understand **what enables business practices to be tailored toward the realities of marginalised producers (Chapter 5**). I used a practice-oriented approach to assess everyday business practices by traders and motorbike milk aggregators in solving everyday problems to help integrate pastoralists into milk markets. I term this as "alignment capacity" for traders, including producers, to milk markets without disrupting their production strategies. Alignment capacity entails changing internal business practices and external practices. Internal alignment capacity entails different strategies in milk sourcing, which navigate dry season milk deficits and higher milk prices. External alignment capacity entails rulemaking and coordination with motorbike milk aggregators across varying time and space.

As such, this research has highlighted the need to use a diagnostic approach to understand what works in what context instead of having preconceived and predetermined marketing strategies. I note that commercialisation will be impactful to LED if it aligns with the local production needs and culture. In doing so, I highlight the key role and agency of the private sector in shaping inclusive business practices.

6.3 Theoretical implications

6.3.1 Conceptualise technology in a way that qualifies context

The chapters in this thesis contribute to bridging the gap between global LED strategies and local-level realities. I achieve this by "opening up" (Leach et al., 2010b) to understand LED beyond the technocentric approach and situating LED practices within socio-institutional contexts. The seminal works on pathways to sustainability (Leach, Scoones, & Stirling, 2010a) show transformation as a continuously changing process. These works acknowledge that technology is made of technical and social elements, making socio-technical change complex, nonlinear, situated and contingent (Glover et al., 2016; Jansen and Vellema, 2011). Chapter 2 provides an empirical example of assessing heterogeneity. By understanding the transition trajectories (stepping up, hanging in or dropping out) for diverse types of producers' development, actors can tailor strategies that are specific to various farmer typologies, which acknowledges multiple development pathways and alternative (competing) framings. Chapter 3 demonstrates the need to

conceptualise intensification as a continuum and not a binary question on whether to intensify or not. Rural studies on livelihood strategies often depict intensification and diversification as distinct strategies (Scoones, 2009). This thesis gives reason to pay more attention to this interrelatedness by "opening up space" to discover how intensification and diversification link and the possible synergistic interactions between the two concepts.

Additionally, this thesis shows the need for an alternative way of looking at LED that acknowledges context across various levels. Instead of conceptualising climate and society as separate entities, the two aspects are better conceptualized as intertwined, dynamic, and co-productive (Taylor, 2015). For example, top-down strategies aimed at modernising dairy through intensification and commercialisation do not account for inclusivity and distributional aspects. However, Chapter 5 shows how transformation that builds on local needs and societal needs imposes significant structural changes to certain parts of society (e.g., marginalised pastoralists) but does not align with national development goals. Such change is firmly rooted in traditional knowledge systems and cultural practices (Feola, 2015).

6.3.2 Context of an enabling business environment

Accounting for heterogeneity at the farm level alone is not sufficient. I used theory to qualify differences in context at the business systems level. Previous applications of BST have been used in industrialised sectors. This thesis extends the framework to sub-national analysis within the agricultural sector. To neatly fit the BST within the agriculture sector, two new indicators were added to the BST, which include commercialisation and intensification. For commercialisation, I evaluated the role of non-lead actors and other development organisations that shape business systems. In *coordinated* business systems, donor organisations play a more pivotal role in shaping the business system by establishing a community-owned milk processor. While in the *coordinated artisanal* business system, independent traders have higher control of the milk market. Failure to acknowledge such nuances risks excluding certain areas from LED-related development strategies.

Using the business systems perspective opens space to start from a grounded diagnostic of what local contexts are capable of before imposing a generic LED pathway. The dominant pathway for intensification is commercialisation, often implemented through lead firms and processors. Formal marketing channels are hypothesised to contribute to bulking of milk and inputs, reducing transaction costs. However, *closed* and *coordinated artisanal* business systems predominantly

feature informal marketing systems. Informal marketing is motivated by timely payments, the proximity of buyers and flexibility in communicating while dealing with one trader. Such business systems are, therefore, not acquiescent to mainstream commercialisation approaches through formal markets. Drastically pushing the informal systems into a formalised pathway risks disrupting functional economic networks that are more adaptable to local needs and fit the agroecological conditions.

6.3.3 Ground agency in performance

The practice approach (Nicolini, 2012) provides a basis to empirically analyse business practice and how it leads to the inclusion of marginalised producers. The analysis demonstrates that inclusion is an emergent rather than a fixed outcome of business practice (Adjei, 2014). While independent traders are seen as part of the informal sector and often labelled as underdeveloped (Schoonhoven-speijer, 2021), they demonstrate a high level of flexibility and adaptability suitable for constantly changing pastoral production systems. Formal milk marketing channels through milk processors are supposed to influence development positively but, in this instance, could not cope with the highly variable nature of milk volumes and milk prices within the pastoral systems. While formal processors aimed at eliminating intermediaries by sourcing milk directly from producers to increase producers' margins, the lack of intermediary engagement contributed to their failure. The success of the trader model was based on the engagement of intermediaries and the coordinated practice with traders to navigate seasonal variability and difficult geographical terrain. The inclusion of the informal sector as an alternative pathway in achieving LED and the inclusion of intermediary actors increases the likelihood of having inclusive marketing strategies, especially for marginalised producers within difficult agroecological terrains.

By using a practice approach, this thesis sheds light on the processes of coordination in sourcing milk from pastoralists. The actions of the traders depend on the actions of the motorbike milk aggregators. For instance, the milk volumes dictate the number and types of buyers to which the traders will sell the milk. Various actors perform distinct roles, and no actor has complete knowledge of all the steps (Jansen and Vellema, 2011). These interdependencies are described as "distributed cognition", where information about certain tasks is distributed across individuals, tools and processes (Hutchins, 1995; Jansen and Vellema, 2011). This denotes the need to "open up" and consider marketing strategies that are not only based on top-down, used by lead firms but

to consider the possibility of using tailor-made solutions (Schoonhoven-speijer, 2021) within specific contexts.

6.4 Reflections on the methodological approach

This section provides reflections on the methodological choices that shaped the research. A mixed-methods design was used. This enabled the triangulation of results (Creswell, 2015) by using diverse sources of information. The combination of the various methodological choices helped to establish the connection between outcome patterns at the household level, institutional aspects shaping uptake of LED at various business systems and practice-oriented case studies helping unpack business actors' agency in enhancing inclusion for marginalised producers. This approach provided a unique contribution to understanding heterogeneity across multiple levels; at household, business systems and market levels.

In doing so, various units of analysis were employed. To understand household-level dynamics that are likely to influence the uptake of LED, the household was used as a unit of analysis (chapters 2 and 3). While a business system was used as a unit of analysis to assess how relations between firms and social institutions result in "societally distinct modes of coordinating economic action" (Redding, 2005, p.11; Whitley, 2007, 1999). This means that several practices in a single geographical space blend and mutually support each other to form a unique and distinct business system. Daily practices were used as a unit of analysis to understand traders' practices in shaping inclusivity in milk markets (Chapter 5). Finally, three validation workshops were held at the district and national levels to triangulate information gathered from various sources.

6.4.1 Embrace a diagnostic approach that is more context-specific

In Chapter 5, I used a case study approach which provided rich data and a detailed description of traders' practices in milk marketing. Taking daily practices as a unit of analysis provided a unique opportunity to combine observed facts on business practice and agency and view them not through single isolated action, but as an emergent outcome rising from a series of practices (Nicolini, 2012). The in-depth analysis (Gerring, 2004) enabled me to unravel how business practices work, where and for who. This required an analysis of what traders do by zooming in on the performance of everyday activities: *how much milk do traders have, which motorbike milk aggregators brought the milk, what volumes does each rider bring, where does the rider source the milk, who did you sell the milk to, what changes during the dry season?* Through an iterative process of data

collection, analysis, and writing, I captured everyday actions and how they shape agency and, eventually, business practice.

Case studies are context-specific and might be viewed as poor for providing external validity. This would limit the generalisability of the research. I addressed this shortcoming by selecting pastoralists who had a history of selling milk through processor-based models and independent traders. Selecting pastoralists who had experience in both marketing models provided useful dynamics and differences in the practices employed by traders and intermediaries. Consequently, the findings from the case study can be generalisable to contexts where processor models and independent trader models are employed in pastoral systems. To complement the rich qualitative data, quantitative data on milk volumes and milk prices over the previous five years were used to tell a complete story. A quantitative survey was also conducted within the district to situate the dynamics of the pastoralists selling milk within the wider context of the district.

The case study provides a framework for implementing a diagnostic analysis. Combining the case study and the lens of practice shifts focus from the evaluative question of whether producers sell milk or not to answering a different question on how milk marketing happens, for whom and under what conditions. Rodrik (2010) suggests a more diagnostic approach to development, through the conscious use of variety (Redding, 2005) to capture the needs and realities of the local development agenda, which potentially makes inclusive development more likely (Waller et al., 2020). Using a case study, we can unravel the modalities of inclusion, which are continuously negotiated (Helmsing and Vellema, 2011a; Muilerman and Vellema, 2016), and the outcomes are conditioned by how they are embedded within territorially specific social norms and politics.

6.4.2 Move beyond methodological individualism.

Methodological Individualism is founded on the premise that the individual is the primary unit of analysis (Neck, 2021). The alternative – methodological holism (or collectivism) focuses on a group (e.g., farmers' cooperatives, the state), which regards individuals' behaviour as completely determined by the collective (Neck, 2021; Rios Pozzi, 2007). I argue, for the need to consider the individual and the collective simultaneously (Neck, 2021). My analysis starts with the individual household level analysis (chapters 2 and 3), using sophisticated econometric analysis of the heterogeneity of households and the relationship between intensification and household diversification. However, I have looked beyond the individual to understand business systems

(Chapter 4) and how they influence individual choices in the uptake of LED. I analysed the emergent properties of the business systems and linked these to pathways for LED strategies.

Additionally, by using a case study approach, I zoomed in on a particular place to understand the dynamics that shaped LED in a specific community in milk marketing (Chapter 5). I demonstrated that a behaviour of a group of people – in this case, milk traders – changes the nature of social action and individual actions – in this case, pastoralists selling milk. While methodological individualism has been instrumental in explaining a range of complex phenomena (e.g., collective action (Hardin, 1968) and social mobility), it is important to move beyond methodological individualism (Rios Pozzi, 2007) to understand complex concepts like LED.

6.5 Implications for policy and development

6.5.1 The need for plural and inclusive pathways

While commercialisation and intensification are the dominant LED narratives in most policy documents, diverse producers will require various strategies and will be supported by diverse market conditions with varying household outcomes. Understanding the heterogeneity of actors helps in the understanding of factors that shape differentiated pathways for LED.

Dominant pathway: Intensifying households are more endowed in wealth and assets, have diversified income portfolios and are more likely to align with the LED narrative of intensification and commercialisation. These are more likely to sell through lead firms under *fragmented business systems*; they present "quick wins" for LED development strategies and moderate GHG emission reduction gains. Since these farmers also tend to be more affluent, variants of *technological* packages plus market-based interventions delivered through lead firms will appeal to these producers.

Alternative 1: Semi-intensifying households have higher absolute incomes, less income diversity and rely more on cash crops. They are more likely to be under informal marketing arrangements to fetch higher prices from milk under *closed business systems*. These households require more innovative strategies in extension because they are not integrated into strong farmer cooperatives. They require tailored information for capacity strengthening and bundling of dairy with other existing farm activities (e.g., tea production). They provide higher GHG reduction gains if they take up additional LED practices. A mix of market incentives, value chain development and

concessionary access to better quality input and extension services could serve to catalyse the adoption of LED practices for this group. Properly thinking through commercialisation options for this group would be paramount. Commercialisation can be seen as a cultural move before being economic, which requires producers to transition from non-utilitarian to utilitarian rationality (Feola, 2015). This would mean a reconfiguration of local structures from consumption and informal trade to recreate new social roles and institutions that enable formal trade.

Alternative 2: Extensive producers are less likely to align with the current LED narrative and are the biggest losers if a technocentric approach and commercialisation from a Lead firm approach are used. They are not motivated to adopt intensification practices because they do not align with their production systems or their agroecological conditions. More innovative strategies (e.g., proper management of grazing lands and innovative needs-driven marketing strategies) are more appealing to these producers. Using a bottom-up approach that accounts for the real needs of producers would lead to more inclusive rural development. Such a pathway would entail inclusive participation (Feola, 2015), which builds on the empowerment of local producers, traders, and other community actors to self-organise and drive LED through innovation that builds on local production needs and social and cultural traditions. Such a pathway is endogenous and relies on local knowledge, innovations and inputs as an alternative to external input and often extractive economies (Feola, 2015). This can be seen as an alternative pathway or even an alternative to development altogether (Escobar, 1995), especially when LED strategies are not responsive to local needs.

6.5.2 Situate LED in the context of existing business systems

Although our findings point to the need to situate LED strategies within the socioeconomic context at the household level, it is also paramount to situate LED strategies in the context of existing business systems. LED policies focus on commercialisation as a key driver of intensification. However, more focus is laid on formalised marketing strategies. There is a need to have a more nuanced approach toward dairy commercialisation and have markets flexible enough to adapt to the needs of the producers and their unique production systems. This would be achieved by understanding the local market dynamics and building from what works instead of introducing disruptive strategies. Other, broader issues affect production (e.g., fluctuation in prices). This is especially important for input prices for concentrates and minerals that have major implications

for production costs. In addition, LED happens at times when there is significant uncertainty and when many other options and ideas are prevailing. Therefore, anticipating disruptions like the COVID-19 pandemic and the current global fuel and food price spike would be an important aspect of situating LED in a dynamic, changing world situated in distinct business systems.

6.5.3 Implications for inclusion

Addressing who wins, who loses and whose interests prevail is vital (Scoones, 2022) in designing impactful LED strategies. Recognising that LED policies affect multiple dimensions of society, economy, environment, and culture in complex nonlinear ways is paramount. Allowing plural LED pathways will increase the likelihood of including producers who would otherwise be excluded by the dominant LED narrative. Some pathways may benefit a narrow field of interests and exclude others, this would result in the exclusion of other producers in ways that undermine their livelihoods and reduce opportunities for emission reduction. Strategies tailored to fit the interests and goals of distinct kinds of farmers and distinct marketing arrangements have a greater chance of achieving both GHG emission reduction targets and inclusive socio-economic development. For complex concepts like LED, proposed strategies should be broad enough to allow potential users a wider scope for the adjustment and adaption of practices that suit their local conditions (Glover et al., 2019). Providing opportunities for practitioners to employ a more grounded approach on what works where will help move from the vague framing of global policies to a more normative standpoint.

6.6 Conclusion

The objective of this thesis was to assess the local-level dynamics within households, business systems and markets to anticipate whether and how global-level policies on LED can align with local realities. The technocentric thinking dominant in LED strategies creates a gap between global strategies and local-level realities. My thesis identified the following conditions that enable alignment as a necessary step to reconstruct social benefit. First, I demonstrated the importance of accounting for diverse socio-economic profiles, interests, and needs. If LED is promoted as a technological fix with intensification and commercialisation as the dominant narrative, the particularities of local dairy development needs will be overlooked. Secondly, LED strategies should account for diversity and allow for plural implementation strategies. In doing so, LED strategies will account for the complex reality of commercialisation, agroecological differences,

and socio-economic profiles. Third, there is a need to account for and leverage the benefits of informal markets and endogenous market development processes. Finally, differentiate between production systems. Different livestock production systems are preferred by diverse producer types on various socioeconomic profiles across varying agroecological conditions, and these serve distinct roles for households. Technocrats advancing LED policies tend to overlook extensive producers and pastoralists, deeming them unproductive with higher emission intensities, without contextual knowledge of the true effects of their production systems on livelihoods and the environment. As such, dairy production systems cannot be bundled together. A more disaggregated and nuanced approach is necessary for understanding farm-level, business systems and market-level dynamics across varying dairy production systems. In doing so, LED will unlock different win-win-win strategies unique to each farmer's typology, situated in different business systems and production systems. This will enable both livelihood and mitigation gains.

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Summary

Summary

The increased global focus on reducing emissions has seen an increased focus on Low Emission Development (LED). Global strategies often follow a technocentric view of increasing productivity and commercialisation. In theory, increasing productivity can help reduce emission intensities, while simultaneously increasing, income and food security. However, farmers are not driven by emission reduction as their primary production objective. In addition, technocentric approaches take a "one-size-fits-all" approach, failing to appreciate how farmer heterogeneity affects the uptake of new practices. Such approaches also ignore the fact that benefits derived from intensification are often unevenly distributed across social classes. The effect of other non-farm socio-institutional conditions on LED uptake is also not well documented. For instance, how distinct socio-institutional systems result in distinctive types of market rules, firms, and actors, that create various typologies of economic organisation with different outcomes on LED. This includes the role of the state in economic organisation, the coordination and competition among private sector actors – and how these interactions would potentially create distinct spatially bound business systems with varying effects on LED. Finally, taking commercialisation to only mean integrating farmers into formal markets, might overlook existing localised market solutions – organised by locally embedded actors – that are responsive to local production goals and cultural traditions.

This thesis addresses the above research gaps to assess how local level dynamics within households, business systems and markets would align with global level policies on LED. The empirical research focused on the dairy sector in Tanzania. However, in chapter 3 a comparative analysis across various research sites in Kenya and Tanzania is employed to improve the external validity of the findings. The overal objective of the thesis **is to assess the local-level dynamics within households, business systems and markets in order to anticipate whether and how global-level policies on LED can align with local realities**.

Moving away from "top-down" technocentric approaches needs a better understanding of socio-institutional contextual aspects that would influence the uptake of LED. The pathways approach was used tounderstand potential implimentation pathways. To unpack diversity across various levels a multi-level approach is employed across the farm, business systems and market levels. Using a quantitative approach to social sciences a multivariate cluster analysis was used to interrogate farmer heterogeneity. Beyond the farm, a business systems approach was used to

evaluate distinct economic organisations and the aspects that enable LED across spatially distinct business systems. Finally, a practice approach was used to understand traders' practices and how this shapes agency. This approach allows us to undertake a holistic analysis of the socio-economic, and institutional aspects that shape the alignment of LED strategies across multiple levels. In doing so, this thesis responds to the folllowing research question. **What conditions enable alignment between LED strategies and local dairy development practices that ensure emission reduction and social benefits across diverse and heterogeneous systems?**

Chapter 2 assessed pathways for scaling LED that better account for divergent smallholder capabilities, interests, and production goals. A multivariate cluster analysis was used to evaluate producer heterogeneity across four districts in Tanzania. Results revealed six distinct farmer types differentiated by their asset ownership, income diversity, cattle breeds, and milk marketing options. The six groups were organised around three levels of LED uptake, high (intensified), moderate (semi-intensified) and low (extensive). Depending on the level of production different groups would need different technological and market incentives to adopt LED. The intensifying group provides an opportunity for "quick wins" in LED uptake while extensive producers (least likely to take up LED as currently conceptualised) would require bottom-up solutions that account for their production goals. Mitigation gains will be modest from the intensifying and extensive groups, while semi-intensive groups present the highest mitigation gains. In doing so, the chapter challenges the conceptualisation of LED as a technological fix – noting that successful LED uptake would require government and practitioners to align LED strategies with local development priorities to develop context-specific LED implementation pathways.

Chapter 3 assessed the interplay between dairy intensification and livelihood diversification. This is especially vital in East Africa where dairy farmers operate within diversified mixed crop-livestock production systems – with a mix of crop farming, livestock production and off-farm business. This chapter is based on the presupposition that dairy intensification would lead to specialisation and may require producers to divert land, labour and capital allocated to other livelihood activities, which may reduce dietary and livelihood diversity. A multinomial treatment regression was used to evaluate the relationship between LED and socio-economic gains within households. Drawing on a comparative analysis across various study sites in Tanzania and Kenya, focusing on dairy intensification. Results show contrary to the hypothesis that dairy intensification

enhances livelihood diversity, as well as nutritional diversity and wealth. These findings suggest that for certain sectors e.g., dairy, intensification and diversification may be complementary strategies rather than competing livelihood strategies.

Chapter 4 acknowledges the adoption of LED practices is shaped by wider power relations beyond households, at the business systems, and market levels – which in turn shape agricultural development. The chapter Zooms out of the household to understand the institutional aspects of the business systems. While the dominant narrative in achieving LED in dairy is enhancing intensification and commercialisation such a narrative is potentially exclusionary since not all social groups, and geographical areas are amenable to intensification and commercialisation. Business Systems Theory was used to cross-examine variability across spatially bounded business systems and its implication for LED. Results show four distinctive business systems. Business systems that feature more informal actors are less amenable to mainstream intensification and commercialisation approaches but are more responsive to local production goals, however business systems that have more formalised market structures are more likely to align with LED. However, the informal sector continues to play a key role in facilitating dairy production and accounts for most producers (97%). Therefore, LED strategies should also account for such groups.

Chapter 5 assessed strategies that enable the inclusion of marginalised pastoralist milk producers into milk markets. The mobile nature of pastoralists makes it difficult to include them in milk marketing because of the seasonal fluctuations in milk volumes and the high transaction cost of aggregating milk from transhumant pastoralists. Using the practice approach helped to understand the everyday practices of sourcing milk and the innovative strategies used by several traders in ensuring that pastoral households are integrated into milk markets. Results show how the skilful performance of traders and motorbike milk aggregators in navigating seasonal variability aligned with the logic and interests of pastoralists. The main success factor for this business practice was the flexible approach to marketing by allowing price variations. This was facilitated through skilful coordination with intermediaries and having different types of milk buyers across seasons. This analysis demonstrates how embedded actors (traders and intermediaries) who understand local production needs used their agency to integrate transhumant pastoralists into milk markets.

Chapter 6 bring all this together, and discusses key findings and areas where alignment between LED approaches and local needs is most likely. In doing so, chapter 6 provides the answer to the main research question by identifying four main aspects that will help align global strategies to local realities 1) understanding heterogeneity across the farm and non-farm levels and how distinct groups are likely to take up LED 2) opening up to allow plural implementation strategies that account for local production needs, agroecological differences and socio-economic profiles 3) accounting for and leveraging on informal markets 4) allowing endogenous innovations in shaping commercialisation without external top-down control. The chapter shows a more nuanced approach is necessary for achieving LED, understanding this will create room for tailored LED strategies that account for local dynamics. Therefore, LED strategies should not only be seen as processes of reducing emissions but should also be viewed as processes that engage diverse socio-economic institutions that shape equitable transitions as well as mitigation gains.

This thesis makes several theoretical implications. First, conceptualise technology in a way that qualifies context this would require thinking beyond the technocentric approach, to situate LED strategies within socio-institutional contexts. Such thinking will help account for inclusivity and distributional aspects and allow plural implementation pathways. Second, start from a grounded diagnostic of what local contexts are capable of, before imposing a generic LED pathway. Establish local innovations that work and build from existing structures, such an approach increases the likelihood of inclusive Low emission development. Finally, understand that agency is grounded in performance – everyday practices shape agency viewed as an emergent outcome rather than a fixed top-down strategy, especially in business practice. Additionally, the thesis overcomes the view of intensification as a binary and instead advocates for the need to conceptualise intensification as a continuum. Findings show that households have blends of dairy intensification and farm/livelihood diversification strategies meaning intensification and diversification are interrelated and are potentially additive, which provides reason to view LED in the context of other ongoing livelihood activities within the household.

The thesis concludes by providing implications for policy and intervention design. Policymakers should situate LED within existing development goals and propose strategies that are broad enough to allow a wider scope of malleability to suit diverse conditions. Different producers will require strategies that meet their socio-economic profiles and production goals and will be supported by

diverse market conditions. Recognising that LED policies affect multiple dimensions of society, the environment, the economy, and culture is paramount. Some strategies may benefit a narrow field of interests and exclude others, this would result in the exclusion of various producers in ways that undermine their livelihoods and reduce opportunities for emission reduction. For practitioners: think through inclusivity and equity dimensions of the interventions beforehand – addressing who are the winners and losers and whose interests prevail is vital in designing impactful LED strategies. Finally, practitioners should start with a more grounded analysis of what works where and for whom to move to allow better chances for achieving both emission gains and socio-economic gains.

Samenvatting

Samenvatting

De toegenomen mondiale focus op uitstootvermindering heeft geleid tot een grotere focus op Low Emission Development (LED, lage-emissie-ontwikkeling). Mondiale strategieën volgen vaak een technocentrische visie voor wat betreft het verhogen van de productiviteit en commercialisering. In theorie kan het verhogen van de productiviteit bijdragen aan het verlagen van de emissie-intensiteit, terwijl tegelijkertijd de inkomens en de voedselzekerheid toenemen. Voor boeren is het terugdringen van uitstoot echter geen primaire productiedoelstelling. Bovendien hanteren technocentrische benaderingen het motto 'one-size-fits-all', waarbij de wijze waarop heterogeniteit van de landbouw de invoering van nieuwe werkwijzen beïnvloedt niet wordt onderkend. Dergelijke benaderingen negeren ook het feit dat de voordelen die voortvloeien uit intensivering vaak ongelijk verdeeld zijn over de sociale klassen. Het effect van andere niet-agrarische socio-institutionele omstandigheden op de invoering van LED is ook niet goed gedocumenteerd. Zo is bijvoorbeeld onvoldoende bekend in hoeverre verschillende socio-institutionele systemen resulteren in verschillende soorten marktregels, ondernemingen en actoren, die verschillende typologieën van economische organisatie creëren met verschillende LED-uitkomsten. Dit omvat de rol van de staat in de economische organisatie, de coördinatie en de concurrentie tussen actoren uit het bedrijfsleven – en hoe deze interacties mogelijk afzonderlijke, ruimte-gebonden bedrijfssystemen creëren met wisselende effecten op LED. Tot slot, als er vanuit zou worden gegaan dat commercialisering alleen maar betekent dat boeren in formele markten worden geïntegreerd, dan worden bestaande lokale marktoplossingen – georganiseerd door lokaal ingebedde actoren – die inspelen op lokale productiedoelen en culturele tradities, wellicht over het hoofd gezien.

In deze scriptie worden de bovengenoemde onderzoekshiaten besproken, om zo te beoordelen hoe de lokale dynamiek binnen huishoudens, bedrijfssystemen en markten zou kunnen aansluiten bij het wereldwijde beleid op het gebied van LED. Het empirische onderzoek richtte zich op de zuivelsector in Tanzania. In hoofdstuk 3 wordt een vergelijkende analyse van verschillende onderzoekslocaties in Kenia en Tanzania gebruikt om de externe validiteit van de bevindingen te verbeteren. De algemene doelstelling van de scriptie is het beoordelen van de lokale dynamiek

binnen huishoudens, bedrijfssystemen en markten om te anticiperen of en hoe het Mondiale LED-beleid kan worden afgestemd op de lokale realiteit.

Het loslaten van 'top-down' technocentrische benaderingen vergt een beter begrip van socio-institutionele contextuele aspecten die de invoering van LED zouden kunnen beïnvloeden. De trajectbenadering werd gebruikt om inzicht te krijgen in mogelijke implementatieroutes. Om diversiteit op verschillende niveaus te benutten wordt er een multi-level benadering toegepast voor de boerderij, bedrijfssystemen en marktniveaus. Met behulp van een kwantitatieve. Benadering van de gamma wetenschappen is er een multivariate clusteranalyse gebruikt om meer te weten te komen over de heterogeniteit van boeren. Buiten de boerderij werd een bedrijfssysteemgerichte benadering gehanteerd om afzonderlijke economische organisaties te evalueren en de aspecten die LED mogelijk maken binnen ruimtelijk afzonderlijke bedrijfssystemen. Tot slot werd een praktijkbenadering gebruikt om de werkwijzen van handelaren te begrijpen en erachter te komen hoe dit de machtsverhouding vormgeeft. Met deze aanpak kunnen we een holistische analyse maken van de sociaal-economische en institutionele aspecten die de afstemming van LED-strategieën op meerdere niveaus vormgeven. Deze scriptie reageert hiermee op de volgende onderzoeksvraag. Welke omstandigheden maken afstemming mogelijk tussen LED-strategieën en lokale ontwikkelingen voor zuivel waarmee emissiereductie en sociale voordelen voor diverse en heterogene systemen worden gegarandeerd?

Hoofdstuk 2 bevat de beoordeling van trajecten voor het opschalen van LED die meer rekening houden met de uiteenlopende capaciteiten, belangen en productiedoelen van kleine boeren. Een multivariate clusteranalyse is gebruikt om de heterogeniteit van de producenten in vier districten in Tanzania te evalueren. De resultaten onthulden zes verschillende soorten boeren die zich onderscheiden op basis van hun activabezittingen, inkomensdiversiteit, veerassen en opties voor melkverkoop. De zes groepen werden ingedeeld rond drie niveaus van LED-invoering: hoog (geïntensiveerd), gemiddeld (semi-geïntensiveerd) en laag (uitgebreid). Afhankelijk van het productieniveau zouden verschillende groepen behoefte hebben aan verschillende technologische stimulansen en marktimpulsen om over te gaan op LED. De geïntensiveerde groep biedt een kans op 'snelle winst' bij de invoering van LED, terwijl extensieve producenten (waarbij invoering van LED zoals het momenteel is geconceptualiseerd het minst waarschijnlijk is) bottom-up oplossingen vereisen die rekening houden met hun productiedoelstellingen. De mitigatiewinst zal

bescheiden zijn bij de geïntensiveerde en extensieve groepen, terwijl semi-intensieve groepen kunnen rekenen op de hoogste mitigatiewinst. Daarbij stelt het hoofdstuk vragen bij de conceptualisering van LED als een technologische oplossing – waarbij wordt opgemerkt dat een succesvolle LED-invoering van de overheid en de gebruikers zou vereisen dat de LED-strategieën worden afgestemd op de lokale ontwikkelingsprioriteiten om zo contextspecifieke LED-implementatietrajecten te ontwikkelen.

In hoofdstuk 3 proberen we de positie van de zuivelintensivering in de algemene landbouweconomie te begrijpen. Dit is vooral van vitaal belang in Oost-Afrika, waar melkveehouders opereren binnen gediversifieerde productiesystemen met gemengde gewassen en vee – met een mix van landbouw, veeteelt en off-farm activiteiten. Dit hoofdstuk is gebaseerd op de veronderstelling dat zuivelintensivering zou leiden tot specialisatie en dat dit producenten ertoe zou kunnen dwingen om land, arbeid en kapitaal die voor bepaalde levensonderhoudsactiviteiten worden benut nu voor andere doeleinden in te zetten. Dit zou de diversiteit in voeding en levensonderhoud kunnen verminderen. Voor het evalueren van de relatie tussen LED en sociaal-economische winst binnen huishoudens is er een multinomiale. behandelingsregressie toegepast. Hierbij is voortgebouwd op een vergelijkende analyse van verschillende onderzoekslocaties in Tanzania en Kenia, gericht op de intensivering van de zuivelsector. De resultaten spreken de hypothese tegen en tonen aan dat de zuivelintensivering de diversiteit van het levensonderhoud, de voedingsdiversiteit en rijkdom verbetert. Deze bevindingen suggereren dat voor bepaalde sectoren, zoals zuivel, intensivering en diversificatie aanvullende strategieën kunnen zijn, in plaats van concurrerende strategieën voor het levensonderhoud.

In hoofdstuk 4 wordt erkend dat het invoeren van LED-werkwijzen wordt gevormd door bredere machtsrelaties buiten de huishoudens, bij de bedrijfssystemen en op marktniveaus – die op hun beurt de ontwikkeling van de landbouw vormgeven. Het hoofdstuk kijkt verder dan het huishouden om de institutionele aspecten van de bedrijfssystemen te begrijpen. Terwijl het dominante narratief in het bereiken van LED in de zuivelsector draait om het bevorderen van intensivering en commercialisering, leidt een dergelijk narratief potentieel tot uitsluiting, omdat niet alle sociale groepen en geografische gebieden geschikt zijn voor intensivering en commercialisering. De Business Systems Theory is gebruikt om de variabiliteit tussen ruimtelijk gebonden bedrijfssystemen en de implicaties daarvan voor LED te onderzoeken. De resultaten laten vier

verschillende bedrijfssystemen zien. Bedrijfssystemen met meer informele actoren zijn minder geschikt voor mainstream intensivering en commercialisering, maar reageren beter op lokale productiedoelen. Bedrijfssystemen met meer geformaliseerde marktstructuren kunnen echter eerder afstemmen op LED. De informele sector blijft echter een sleutelrol spelen bij het faciliteren van zuivelproductie en levert nog steeds de meeste producenten (97%). Daarom moeten LED-strategieën ook rekening houden met deze groepen.

In hoofdstuk 5 zijn de strategieën beoordeeld waarmee gemarginaliseerde nomadische melkproducenten in de melkmarkten kunnen worden opgenomen. De nomadische aard van kleine boeren maakt het moeilijk om ze op te nemen in de melkverkoop vanwege de seizoensgebonden schommelingen in melkvolumes en de hoge transactiekosten bij het aggregeren van melk uit de veetrek. De praktijkaanpak heeft geholpen inzicht te krijgen in de dagelijkse praktijk van het inkopen van melk en de innovatieve strategieën die door verschillende handelaren worden gebruikt om te garanderen dat nomadische boeren worden geïntegreerd in de melkmarkten. De resultaten laten zien hoe vaardig handelaren en melkinzamelaars op motorfietsen omgaan met seizoensschommelingen en hoe goed ze hun praktijken afstemmen op de denkwijze en belangen van de nomadische boeren. De belangrijkste succesfactor voor deze werkwijze is de flexibele benadering van de handel door prijsvariaties toe te staan. Dit was mogelijk door een goede coördinatie met tussenpersonen en door de beschikbaarheid van verschillende soorten melkinkopers gedurende de seizoenen. Deze analyse laat zien hoe ingebedde actoren (handelaren en tussenpersonen) die de lokale productiebehoeften begrijpen, hun invloed gebruikten om nomadische veetrekboeren in de melkmarkten te integreren.

In hoofdstuk 6 wordt alle informatie samengebracht en de belangrijkste bevindingen en gebieden besproken waar afstemming tussen de LED-benaderingen en de lokale behoeften het meest waarschijnlijk is. Hiermee wordt in hoofdstuk 6 het antwoord gegeven op de belangrijkste onderzoeksvraag. Er worden vier hoofdaspecten geïdentificeerd die zullen helpen de Mondiale strategieën af te stemmen op de lokale realiteit: 1) inzicht krijgen in de heterogeniteit op boerderij-/niet-boerderijniveau en in de manier waarop verschillende groepen LED waarschijnlijk zullen invoeren2) meer bereidheid om meerdere implementatiestrategieën toe te kunnen passen waarbij rekening wordt gehouden met lokale productiebehoeften, landbouw-ecologische verschillen en sociaal-economische profielen 3) rekening houden met informele markten en deze een rol laten

spelen 4) ruimte bieden aan endogene innovaties in het vormgeven van de commercialisering zonder externe top-down controle. Het hoofdstuk laat zien dat een meer genuanceerde benadering nodig is om LED te bewerkstelligen. Wanneer dit wordt begrepen, ontstaat er ruimte voor op maat gemaakte LED-strategieën die rekening houden met de lokale dynamiek. Daarom moeten LED-strategieën niet alleen worden gezien als processen om de uitstoot te verminderen, maar ook als processen waarbij diverse sociaal-economische instellingen betrokken zijn die zowel gelijkwaardige transities als mitigatiewinst vormgeven. Deze scriptie heeft verschillende theoretische gevolgen. In de eerste plaats moet technologie zodanig worden geconceptualiseerd dat de context wordt gekwalificeerd. Hierbij moet verder worden gekeken dan alleen de technocentrische benadering, om zo de LED-strategieën binnen socio-institutionele contexten te kunnen plaatsen. Met deze manier van denken is er ook ruimte voor inclusiviteit en distributieaspecten en zullen er meerdere implementatietrajecten mogelijk zijn. Op de tweede plaats moet - voordat er een generiek LED-traject kan worden opgelegd - worden vastgesteld wat de mogelijkheden zijn binnen de lokale contexten. Er moeten locale innovaties worden ontwikkeld die werken met en voortbouwen op bestaande structuren; een dergelijke aanpak vergroot de kans op inclusieve LED. Tot slot moet men begrijpen dat invloed rechtstreeks in verband staat met prestaties. De dagelijkse werkwijzen bepalen dat de invloed wordt gezien als een resultaat van iets, in plaats van een vaste top-down strategie, vooral in de praktijk van het bedrijfsleven. Bovendien blijkt uit deze scriptie dat intensivering niet binair is; in plaats daarvan wordt er geijverd om intensivering als continuüm te conceptualiseren. De bevindingen tonen aan dat kleine boerenhuishoudens zuivelintensivering en landbouw- /levensonderhoudsstrategieën combineren. Dit duidt erop dat intensivering en diversificatie met elkaar samenhangen en elkaar mogelijk aanvullen. Dit kan een reden zijn om LED te beschouwen in de context van andere levensonderhoudsactiviteiten die binnen het huishouden plaatsvinden.

Aan het einde van deze scriptie worden de implicaties genoemd voor het beleids- en interventieontwerp. Beleidsmakers moeten LED plaatsen binnen bestaande ontwikkelingsdoelen en strategieën voorstellen die breed genoeg zijn om een bredere vormbaarheid mogelijk te maken, zodat rekening kan worden gehouden met diverse omstandigheden. Verschillende producenten vereisen strategieën die aan hun sociaal-economische profielen en productiedoelstellingen voldoen en worden ondersteund door diverse marktomstandigheden. Het is van groot belang te erkennen dat het LED-beleid invloed heeft op meerdere dimensies van de samenleving, het milieu, de

economie en de cultuur. Sommige strategieën zijn wellicht voordelig voor sommigen, maar kunnen anderen uitsluiten. Dit kan leiden tot de uitsluiting van verschillende producenten die zo niet meer (volledig) in hun levensonderhoud kunnen voorzien; ook kan het de mogelijkheden voor emissiereductie verminderen. Voor de beroepsbeoefenaars: overweeg vooraf goed wat de interventies betekenen voor de inclusiviteit en gelijkheid – wie de winnaars en verliezers zijn en wiens belangen voorrang krijgen is van vitaal belang bij het ontwerpen van krachtige LED-strategieën. Tot slot zouden beroepsbeoefenaars moeten beginnen met een grondigere analyse van wat waar en voor wie werkt. Met deze informatie kunnen zij bepalen hoe er betere kansen kunnen worden geboden voor het bereiken van zowel emissiereducties als sociaal-economische voordelen.

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About the author

About the Author

Esther Kihoro is currently working with the CGIAR Generating Evidence and New Directions for Equitable Results (GENDER) Platform. Her work entails developing high quality evidence and knowledge to contribute to transformational change for inclusive food systems in the face of climate change. In 2017, Esther started her PhD research at the Wageningen School of Social Sciences (WASS). Esther's research focused on social and institutional aspects shaping uptake of low emission practices for smallholder producers in the context of climate change. Her research work was conducted in Tanzania for 1.5 years working with farmers, private sector, development practitioners and government agents. During her PhD she attended the Summer School on Pathways to Sustainability held at the Institute of Development Studies, Sussex University, Brighton, UK. Esther was also invited as a guest lecturer to lecture on various topics at the University of Nairobi. During the last year of her PhD, Esther worked with a global project (STOP Spillover) implemented by Tufts University. The project aims to stop future zoonotic disease spillover in Africa and Asia. Within the project she provided oversight and training on contextualizing the project to fit local realities through participatory engagement and planning with relevant stakeholders and accounting for, socio-cultural and political economy dynamics shaping project implementation.

Before starting her PhD Esther worked with the International Livestock Research Institute (ILRI) as a research associate, looking at crop-livestock interactions within various farming systems, technology adoption and impact assessments. Prior to that she worked at the Kenya Agricultural research Institute (KARI) in collaboration with other scientists to implement youth, men and women cantered interventions. This included training, capacity-building exercises as well as conducting monitoring and evaluation surveys. Esther received a Masters and Bachelor’s degrees in agricultural economics from the University of Nairobi, Kenya. She is motivated by interdisciplinary research focusing on knowledge, practice, power, gender and politics shaping inclusive and sustainable development. She has published in several peer reviewed journals and participated in multiple scientific conferences.

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Colophon

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