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Public Administration and Policy (PAP)

The interactions between the sustainable development goals in theory and practice

Assessing the interactions between SDG2 and other SDGs in the context of dairy production in Kenya

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'The quality of your attention determines the quality of your experience' (Anat Geiger)

Abstract

The Sustainable Development Goals (SDGs) and their targets, which were adopted by all members of the United Nations to deliver sustainable development universally, interact with each other. The SDG framework is a network of SDG targets and includes synergies (positive interactions) and trade-offs (negative interactions) depending on the sectoral and regional context. This thesis aims to contribute to the scientific knowledge on SDGs interactions by creating a better understanding of what trade-offs and synergies between SDG2 and other SDGs in the context of dairy production exist in Kenya and how experts perceive and address these. The identification of interactions between the SDGs provides a better understanding of the processes within a context and allows for more effective and efficient implementation of the SDGs. Firstly, drawing on an extensive structured literature review, this study identified 85 interactions between the targets of SDG2 and the targets of other SDGs in the chosen context. Secondly, during expert interviews, experts recognised the identified interactions and were able to elaborate on the trends in the context - youth moving away from agriculture, lack of energy and poor infrastructure, existing gender roles and the various livestock systems - which explain further the presence of the identified SDG interactions. Thirdly, policy integration, capacity building, increased awareness of SDG interactions and increased actor interaction & alignment are raised as prerequisites by experts to better address SDG interactions and deliver the SDG Agenda successfully.

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Chapter 1: Introduction

1.1 Problem description

Sustainable Development Goals' interactions

In 2015 the Sustainable Development Goals (SDGs) were adopted by all member states of the United Nations as part of the 2030 Agenda for Sustainable Development (United Nations, 2021). The SDGs encompass 17 different goals with 169 targets, which are set up to guide and keep track of national and global efforts to achieve sustainable development (Mainali et al., 2018). Individual SDGs and targets address specific issues concerning sustainable development. Many of these goals and targets are related to each other, directly or indirectly. The goals rely on each other and can be mutually reinforcing or conflicting (Institute for Global Environmental Strategies, 2017). The SDGs framework acknowledges that strategies regarding ending poverty and other deprivations must go hand in hand with strategies that improve education and health, reduce inequality and spur economic growth while tackling climate change and working to preserve our oceans and forests (United Nations, 2021). Based on the wording of the goals and targets, Le Blanc (2015) concludes that of 107 targets, 60 explicitly refer to at least one other SDG than the one to which they belong. This recognition of interdependencies between the targets is what distinguishes the SDGs framework from its predecessor, the millennium goals (United Nations, 2021). In short, the SDGs framework can be perceived as a holistic framework to achieve sustainable development, consisting of seventeen goals which depend on and interact with each other.

Although interactions between sectors and SDGs are acknowledged in the SDGs framework, there is a lack of understanding of the linkages between the different targets and goals across sectors which has resulted in incoherent policies, misalignment, adverse impacts of policies of one specific sector on the other, loss of opportunity to create synergy effects and a delay of sustainable development outcomes (Le Blanc, 2016; Nilsson et al., 2016).

The interdependencies and interactions between the different goals and targets of the SDGs have been subject to research since the 2030 agenda for sustainable development has been adopted. The motivation for this research is the belief that it contributes to the integration and development of coherent policies across sectors to reach the SDGs more effectively (Fader et al., 2019; Mainali et al., 2018; Waage et al., 2010; Weitz et al., 2014; Weitz et al., 2017; Pham-Truffert et al., 2020; Breurer et al., 2019; Nilsson, Griggs & Visbeck, 2016; Le Blanc, 2015; Institute for Global Environmental Strategies, 2017; ICSU, 2017; Rueff & Messerli, 2019; Da Silva et al., 2020; Fader et al. 2019; Kamau & MacNaughton, 2019; Pradhan et al., 2017).

Despite these efforts, the nature of SDGs interactions and how to best address trade-offs and utilise synergies between SDGs is unclear. Several researchers call for contextual research on SDGs interactions as SDGs targets' effect on another is highly contextual (Nilsson et al. 2016; Weitz et al. 2017; Fader et al. 2019). Bornemann & Weiland (2021) opt for research which focuses on whether and how

specific forms of policy integration of the SDGs 2030 agenda become relevant in local political practice and *"how interaction analyses and goal prioritization look like on the ground"* (Bornemann & Weiland, 2021. p. 104). Thus, although the interactions between the SDGs have been studied in various ways by numerous researchers, unclarity exists on the nature of SDGs interactions in varying contexts and how to best address trade-offs and utilise synergies between SDGs to deliver the SDGs effectively.

Livestock and the Sustainable Development Goals

In Kenya, livestock is crucial for generating income and food for a large share of households that are classed as poor (International Livestock Research Institute, 2021; Brandt, 2018). Because of an increase in population, income and urbanisation, the demand for livestock products is rising. Meanwhile, climate change is negatively impacting livestock production because of rising temperatures and lower annual rainfall, which reduces livestock productivity. Furthermore, there is pressure on food for animals as a result of soil degradation and water scarcity (International Livestock Research Institute, 2021; Brandt, 2018). Alongside the livestock sector being negatively impacted by climate change, the livestock sector contributes to climate change by the emission of greenhouse gasses (International Livestock Research Institute, 2021; Brandt, 2018). This leaves the Kenyan livestock sector in a predicament. According to the FAO (2018), the livestock sector needs a transition to sustainable livestock production, which enhances the sector's contribution to the achievement of the SDGs. Livestock plays a critical role in realising SDG2 'Zero Hunger'. Specifically in realising food security by contributing to global calorie and protein intake. Livestock is not only related to SDG2. The FAO (2021) identified SDG1 'No Poverty', SDG3 'Good Health', SDG5 'Gender Equality', SDG6 'Clean Water and Sanitation', SDG7 'Affordable and Clean Energy', SDG8 'Good jobs and Economic Growth', SDG13 'Climate Action' and lastly, SDG17 'Partnerships for the Goals' to interact with the livestock sector. Not all interactions are synergies for example, the livestock sector is a major contributor to greenhouse gas emissions, therefore contributing to climate change and thereby negatively impacting SDG13 'Climate Action'. The United Nations (2018) reported on the interactions between the livestock sector and all 17 different SDGs in their report 'Transforming the livestock sector through the Sustainable Development Goals'. Instead of only reporting on direct interactions between the livestock sector and the SDGs like the FAO (2021), the UN report (2018) describes that livestock production relates directly or indirectly to every SDG although it is noted that some interactions between the livestock sector and the SDGs are stronger than others. The report identified 19 synergies and 6 trade-offs between the SDGs in the global livestock sector (United Nations, 2018). The report did not investigate if and how these interactions differ in diverse geographical contexts.

Ashley (2019) conducted a policy coherence analysis regarding climate and livestock in three African countries, including Kenya. Ashley analysed 14 Kenyan policies regarding climate, livestock & agriculture, development, land and environment. The study finds that Kenya is well-performing in integrating livestock sector adaption and mitigation strategies as the Climate Smart Agriculture

Strategy/Implementation Framework, 2018-2027, and National Climate Change Action Plan, 2018-2020, provide adaptation and mitigation strategies for the livestock sector and are well-aligned with the SDGs. Furthermore, policy coherence exists for livestock sector adaptation among Kenya's livestock, key developments, and one land policy, yet mitigation strategies are lacking. Although policy coherence is present regarding climate and livestock by national policies, unexploited synergies and unaddressed trade-offs exist because of misalignments between national public actors and international public and private actors. In the Kenyan livestock sector, multilateral development programs are not always aligned with national policies (Ashley, 2019). The potential lack of alignment between these actors and across SDGs whereby synergies and trade-offs are not addressed results in inefficient efforts to deliver the SDGs (FAO, 2018).

Academic consent exists regarding the existence of interactions and interdependencies between the SDGs and targets. Yet, limited research has been performed on context-specific interactions between the SDGs and the lack of alignment of efforts by different actors. Additionally, no attention in former studies is given to the perception of stakeholders active in the field to deliver the SDGs in practice, and how these stakeholders address the interactions.

For the livestock sector to contribute to the achievement of the SDGs, there is a need to better understand the nature of the trade-offs and synergies between SDGs relating to the livestock sector. By getting a better understanding of SDGs interactions in the case of livestock in Kenya, policymakers can acquire this knowledge to better coordinate these interactions, align national policies with international and private initiatives and contribute to the SDGs. In this thesis, an attempt will be made to identify the possible trade-offs and synergetic relations between SDG2 'zero hunger' and other SDGs regarding dairy production specifically. Subsequently, it will analyse the perception of the identified SDGs interactions by key informants and how these experts address the interactions in projects aiming to realise sustainable development regarding dairy production in Kenya. By limiting the scope of this thesis to the case of dairy production in Kenya specifically, this thesis complies with the call by researchers to investigate SDGs interactions in a specific context (Bornemann & Weiland, 2021; Fader et al., 2019; Weitz et al., 2017).

1.2 Research aim

This thesis aims to contribute to the scientific knowledge on SDGs interactions in theory and practice by creating a better understanding of trade-offs and synergies between SDG2 and other SDGs in the context of dairy production in Kenya. Interactions between SDGs are identified based on academic literature. Additionally, it is investigated how experts working in this context address and perceive SDGs interactions will be investigated. Lastly, insights are collected on what according to experts is needed to better address trade-offs and utilise synergies between the SDGs. By doing so this thesis contributes to the limited insights on SDGs interactions in a specific context. It contributes to the integration and development of coherent policies across sectors to deliver the indivisible SDGs agenda.

1.3 Research questions

The following research question will be answered in this thesis:

What interactions between sustainable development goal 2, and other sustainable development goals exist in the context of dairy production in Kenya, and how can they be addressed?

To answer this research question, the following sub research questions are formulated:

RQ1.   What interactions exist between the targets of SDG2 and the other SDGs regarding dairy production in Kenya?

RQ2.   How can interactions between SDGs in the context of dairy production in Kenya be addressed?

1.4 Thesis structure

The remainder of this thesis report is structured as follows: Chapter 2 addresses the underlying theories and concepts of this study. Chapter 3 explains the methodological approach of this thesis and provides an introduction to the chosen context of this thesis; dairy production in Kenya. Additionally, the chapter describes the process of data collection and analysis as well as dives into the limitations of this methodological approach. In chapter 4 the results of the study are presented. Chapter 5 discusses the results of the study and puts the results in the broader research context. The thesis ends with a conclusion and recommendations in chapter 6.

Chapter 2: Conceptual Framework

This thesis aims to assess what interactions between SDG2 and other SDGs in the context of dairy production in Kenya exist and how experts from the field perceive these interactions, to contribute effectively to the achievement of the SDGs. In this chapter, the conceptual framework of the study will be explained. It provides a better understanding of the concept of sustainable development, theories on governing sustainable development, the framework of the Sustainable Development Goals and the lens through which the SDG interactions were studied.

2.1 Sustainable development

In the 1980s, the concept of sustainable development emerged in an attempt to explore the relationship between development and the environment (Banerjee, 2003). The motivation behind the development of this concept was to be able to manage environmental resources to ensure both sustainable human progress and human survival (WCED, 1987). Scientists foresaw environmental trends threatening to alter the planet radically, as well as identified failures of development. The Brundtland Commission of the World Commission on Environment and Development (WCED) defined sustainable development as *'a process of change in which the exploitation of resources, direction of investments, orientation of technological development, and institutional change are made consistent with future as well as present needs'* (WCED, 1987, p. 9). This definition is critiqued by many for its vagueness and the lack of the Brundtland report on ways how to achieve sustainable development. Hart's (1997) and Banerjee's (2003) main critique is that this definition prioritises development over the environment. Despite that, this definition is most used (Banerjee, 2003).

In an attempt to broaden the scope of sustainable development to include social sustainability, Elkington (1998) developed the framework of the triple bottom line. During the mid-1990s Elkington (1998) developed this framework to measure sustainability by not only measuring economic and environmental performance but including performances on social dimensions. Despite the disagreement on the definition of sustainable development, there exists a broad consensus that sustainable development consists of a combination of economic development, environmental sustainability and social inclusion (Griggs et al., 2014; Shi et al., 2019).

2.2 Governance of sustainable development & the SDGs

An integrated and holistic governance approach to sustainable development is crucial to achieving real progress according to scientists, UN agencies, the private sector and civil societies (Boas, Biermann & Kanie, 2016; Griggs et al. 2013; Raworth 2012; UNEP 2015; Young et al. 2014; Zerrenner 2014). Governance is explained as a model of social coordination (Shi, et al., 2019). Governance is how one acts through multiple types of interactions and to what extent the participants adhere to collective decision making (Kemp,

2015). It should be emphasised that governance varies with different environments and cultures (Shi et al., 2019).

The governance of sustainable development can be seen as *'processes of socio-political governance oriented towards the attainment of sustainable development'* (Meadowcroft, 2007, p. 299). Good governance is a prerequisite for achieving sustainable development, according to many (Shi, et al., 2019; Demmers, et al., 2004; Stojanoviç et al., 2015; Meyer, 2019). It includes social transformation processes by governments, market actors and civil society, at various levels (local to international). In addition, good governance affects different policy fields and refers to multiple temporal scales (Lange et al., 2013).

In the context of sustainable development, concentrated global efforts are needed to achieve all three dimensions and thus achieve sustainability, globally (Griggs, 2012). Global efforts are needed as humanity is changing its environment up the global scale (Hoff, 2018) and several resources like water cross political boundaries thereby demanding transitional governance to achieve global sustainable development (Hoff, 2018; Boas, Biermann & Kanie, 2016). At the same time, governance arrangements should acknowledge and fit diverse global contexts.

In 2015, the international community agreed on a comprehensive, non-binding framework of goals, targets and indicators to guide sustainable development, the SDGs framework (Bornemann, Weiland, 2020). The framework consists of 17 global goals and these were designed to be interconnected and indivisible, to reflect the challenges faced today: to alleviate poverty and ensure human prosperity while protecting the planet and its resources (Pham-Truffert et al., 2020; Breurer et al., 2019). By doing so, the SDGs framework takes a global approach and includes the three dimensions for sustainable development (Nilsson et al., 2016). Compared to its predecessor, the Millennium Development Goals, the SDG framework leans further towards integrating different policy domains in many ways (Boas, Biermann, & Kanie, 2016). Furthermore, the SDGs are unique because of the non-binding nature of goals, the reliance on weak institutional arrangements and the extensive leeway that states enjoy (Biermann, Kanie & Kim, 2017).

Since the establishment of the SDG framework, researchers express the need to account for the diverse contexts as well as direct attention to the indivisibility and interconnectedness across dimensions in SDG implementation (Yunita et al., 2022; Biermann, Kanie & Kim, 2017; Horner, 2020; Breurer et al., 2019; Griggs et al., 2013). The framework is a universal attempt to deliver sustainable development, yet the SDGs are implemented in very diverse contexts with different institutional arrangements for the SDGs (Yunita et al., 2022; Biermann, Kanie & Kim, 2017). While attempting to achieve universal sustainable development, the extreme variety of challenges, circumstances and choices that shape prospects and prosperity for all everywhere should be accounted for (Yunita et al., 2022; Horner, 2020). Thus, SDG implementation should attend to the varying institutional arrangements for the SDGs, and the political and economic assumptions in the diverse contexts (Yunita et al., 2022). Secondly, the indivisibility and

interconnectedness across dimensions may result in targets of one SDG overlapping, reinforcing or contradicting the targets of other SDGs (Breurer et al., 2019; Griggs et al., 2013; Boas, Biermann & Kanie, 2016). The interlinkages among and between the different goals and targets need to be identified and addressed adequately in a broad variety of contexts (Hoff, 2018).

Integrated approaches for SDG implementation

To overcome contradictions and overlap between SDG targets and to acknowledge the diverse contexts globally, an integrated approach is needed to deliver SDGs effectively (Breurer et al., 2019; Stafford-Smith, Griggs & Gaffney; 2017; McGowan et al., 2019). Several integrated approaches are proposed by scientists: the nexus approach (Boas, Biermann & Kanie, 2016), the concept of planetary boundaries (Rockstrom et al., 2009) earth system governance (Biermann 2007), and the principle of environmental policy integration (Lafferty and Hovden 2003; Nilsson et al., 2009; Biermann et al., 2009; Jordan and Lenschow 2010).

Waage et al., (2015) were inspired by the doughnut developed by Raworth in which an environmental ceiling based on the planetary boundaries is combined with a social foundation for which it is unjust for people to fall below (Raworth, 2012). Waage et al., (2015) applied the SDGs to the doughnut and developed a new doughnut framework in which people-centred SDGs are centred (the inner circle). These goals rely on and are embedded with the middle circle which includes SDGs related to the production, distribution and delivery of services (Figure 1). The outer circle includes SDGs related to natural resources and ecosystems on which the middle circle depends. Two SDGs, SDG16 and SDG17 are outside the model as underlying and enabling goals. The doughnut framework does acknowledge that the SDGs are related, yet it does not elaborate on the links between the SDGs and their targets nor allows it to illustrate that for some goals, targets are spread across different levels.
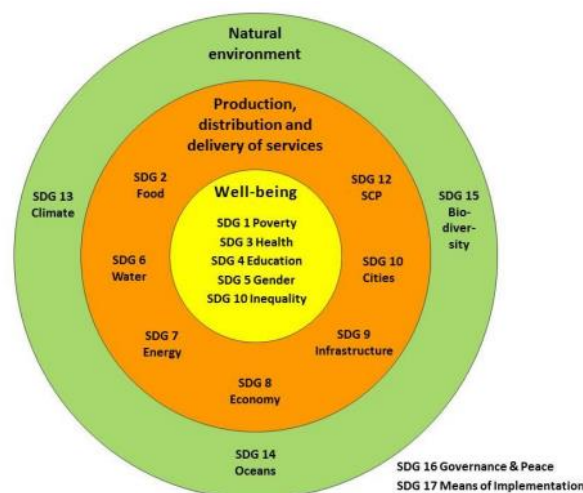
Figure 1: Clustering of SDGs according to Doughnut framework based on Waage et al., (2015) (Niestroy, 2016).

Environmental policy integration incorporates environmental concerns in other policy domains but is focused on environmental policy integration only (Boas, Biermann & Kanie, 2016). Therefore, it is unsuccessful in including multidirectional integration across all seventeen SDGs.

A nexus approach provides a foundation for integration within the SDGs and bridging sectoral silos, thereby contributing to the achievement of the end goal of sustainable development (Lim, Jorgensen & Wyborn, 2018; Hoff, 2018; Boas, Biermann & Kanie, 2016). Nexus is defined in the Oxford Dictionary (2022) as *'a connection or series of connections linking two or more things'.* Boas, Biermann & Kanie (2016) elaborate on how it can be applied to several sustainable development objectives and allows for a fully integrative perspective toward sustainable development. In most cases, nexus approaches are applied to specific clusters of SDGs, i.e. the energy-food nexus. The interconnectedness and indivisibility across dimensions and goals of the SDG framework invite a nexus approach during the implementation of the framework (Hoff, 2018; Boas, Biermann & Kanie, 2016).

When taking an integrated approach to sustainable development, a demand for more policy coherence; across sectors, geographical borders, time and between private and public actors is needed to deliver the SDGs effectively (Breurer et al., 2019; Stafford-Smith, Griggs & Gaffney; 2017; McGowan et al., 2019; Azizi, Biermann, Kim, 2019; Breurer et al., 2019; Liu et al., 2018). The OECD (2019) defines policy coherence as *'an approach to integrate the dimensions of sustainable development throughout domestic and international policy-making'.* Yunita et al. (2022) describe the underlying assumption which motivates the appraisal of policy coherence, that ineffective, inequitable and unsustainable development interventions are the consequence of fragmented, siloed, and therefore incoherent institutional policy design. In line with the nexus approach, policy coherence for sustainable development requires horizontal coherence (across policy sectors), vertical coherence (between different levels of government), balancing short-term priorities with long term sustainability, balancing domestic policy objectives with internationally recognised sustainable development goals (Boas, Biermann & Kanie, 2016; OECD, 2019a; OECD 2019b).

2.3 Understanding SDG interactions

Because of the interconnectedness and indivisibility of the SDG framework, the SDGs are seen as a network of related targets (Le Blanc, 2015). This view of the SDGs as a network of targets recognises interdependencies between different sectors and targets in delivering sustainable development. Several researchers acknowledge this view and have studied the interactions between the SDGs at the target level (Pham-Truffert et al., 2020; Weitz et al., 2017; Nilsson et al., 2016; Mainali et al., 2018; ICSU, 2017; OECD, 2019; Biggeri et al., 2021; Bornemann & Weiland, 2021; Le Blanc, 2015). Nilsson et al. (2016) distinguished the interactions by the nature of the interaction; positive interactions, 'synergies' and negative interactions, 'trade-offs'. In the context of the SDG framework, a synergy implies the impact of making progress on the delivery of a combination of SDG targets is greater than the sum of the individual impact

of activities (Mainali, 2018). Thus, actions or measures taken to realise one goal mutually reinforces the delivery of another related goal. Activities to deliver both SDGs reinforce each other. The presence of a trade-off in the SDG framework implies that progress in one SDG hinders the progress in another SDG.

To achieve policy coherence in implementing the SDGs, it is important to understand SDG interactions specifically, because of the possible trade-offs and synergies present (The Institute for Global Environmental Strategies, 2017). When interactions, trade-offs or synergies are not addressed, progress in the delivery of one target comes at the expense of progress in another SDGs target or opportunities to mutually reinforce two targets are missed. Breurer, Janetschek & Malerba (2019) call for the need of disentangling complex interactions between the SDGs and SDGs implementation cross-sectoral processes to foster policy coherence to successfully implement the SDGs. By disentangling complex interactions between the SDGs and the targets the academic field can better support policymakers to think systematically about SDGs interactions, within and between sectors and achieve long-lasting sustainable development outcomes (OECD, 2019; Breurer et al., 2019). Bornemann & Weiland (2021), Nilsson et al. (2016), Fader et al. (2019) and Weitz et al. (2017) call specifically for research on SDG interactions in specific contexts as SDGs targets' effect on another is highly contextual.

Interactions between SDGs can be studied in numerous ways, varying from the level and context in which they are studied and accounting for the varying degrees in which they differ.

Firstly, SDG interactions can be investigated at different levels; goal-goal interactions, target-target interactions, indicator-indicator interactions, policy-policy interactions and interactions across goals, targets, indicators and/or policy (Bennich, Weitz and Carlsen, 2020).

Secondly, SDG interactions can be studied in general or in a specific context, geographically and/or sectoral. The majority of studies on SDGs interactions have studied SDGs interactions in general. Several researchers call for research on SDGs interactions in specific contexts as SDGs targets' effect on another is highly contextual (Nilsson et al., 2016; Weitz et al., 2017). Weitz, Carlsen, Nilsson & Skanberg (2017), conducted a network analysis of SDGs interactions at the target level, in the context of Sweden. Other researchers investigated and provided conceptual frameworks for specific interactions of several SDGs (Da Silva et al., 2020; Fader et al., 2019; Kamau & MacNaughton, 2019). Geographical contexts are proven to matter significantly in assessing SDG achievement (Beninch, Weitz & Carlsen, 2020). Moreover, interactions differ depending on the context-specific social-ecological dynamics (Beninch, Weitz & Carlsen, 2020). Shi et al., (2019) describe that well-intended development projects are unsuccessful because of a lack of consideration of context, local realities, cultural identity, and values.

Thirdly, the degree of interactions can be studied. Besides the distinction of interactions between synergies and trade-offs, typologies of the nature of interactions are established (Nilsson et al., 2016). The typology ranges from cancelling (The most negative interaction where progress in one target makes it impossible to achieve another target and can lead to a deterioration of the second) to indivisible (the strongest form of positive interaction in which one target is inextricably linked to the achievement of the

other). This typology has been applied by several studies and policy documents investigating SDGs interactions (ICSU, 2017; Pham-Truffert et al., 2020; Weitz, et al., 2014; Le Blanc, 2015; Mainali et al., 2018; Institute for Global Environmental Strategies, 2017).

2.4 Conceptual framework of this study

This thesis attempts to provide an understanding of the interactions between SDG2 and other SDGs in the context of cow husbandry in Kenya from a nexus approach. Providing this information to scientists and policy-makers on what needs to be governed, this thesis contributes to future research on ways how to govern SDG interactions. Figure 2 illustrates the conceptual framework this thesis adopts. In this thesis, sustainable development is understood by the three dimensions of the triple bottom line. It embraces the view of the SDGs framework as a network of goals and targets, its interconnectedness and the presence of synergies and trade-offs. This thesis investigates the nature of interactions at the target level of the SDGs framework. The targets of one specific SDG, SDG2 'zero hunger' are taken as the starting point and the interactions between the targets of SDG2 with the targets of other SDGs will be investigated. SDGs interactions are analysed in the spatial context of Kenya and the sectorial context of the dairy sector.
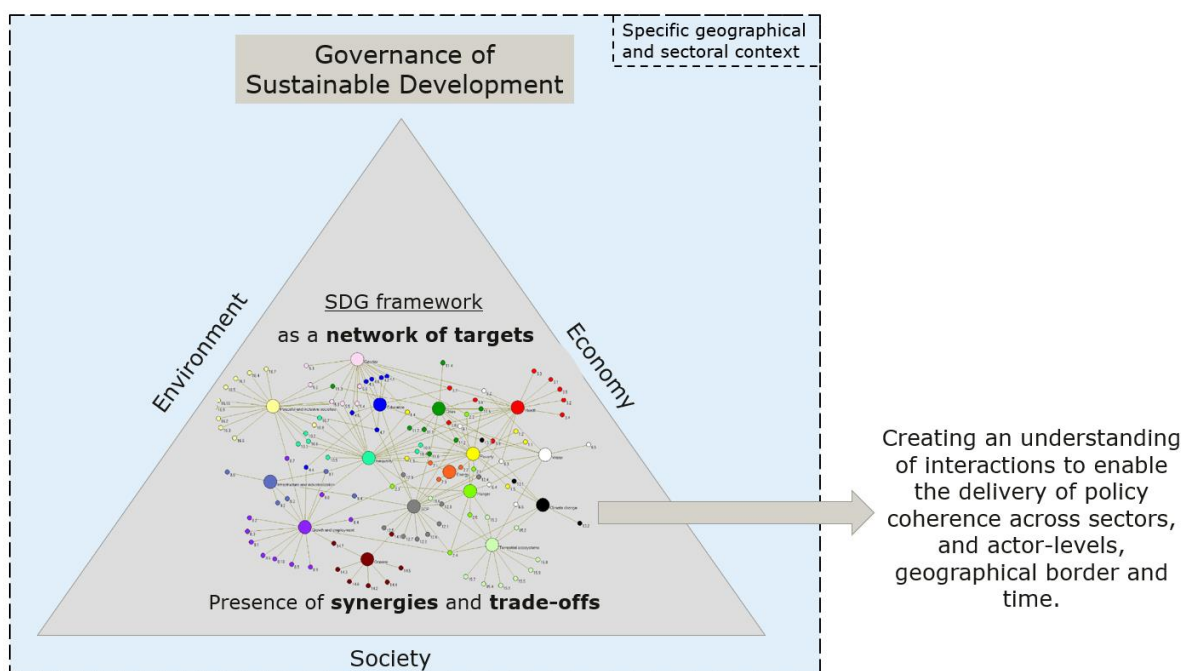
Figure 2: *Illustration of concepts (own representation)*

Chapter 3: Methodology & Methods

This chapter sheds light on the methodology of this thesis. Firstly, the choice of a mixed-method case study research design is explained. Secondly, the methods of data collection and analysis of the structured literature review are discussed. Thirdly, the methods of data collection and analysis of the semi-structured interviews are discussed. Fourthly, the case of dairy production in Kenya is introduced. Lastly, this chapter reflects on the methodological limitations of this thesis.

3.1 Research design

The previous chapter explained how the framework of the sustainable development goals can be seen as a network of targets which interact with each other. Understanding the nature of these interactions in a specific context is crucial in designing governance arrangements to better address and utilise these synergies and trade-offs. This study adopted a mixed case study methodology to identify SDG interactions based on literature as well as to generate a contextualised in-depth view of SDG interactions by conducting interviews. The concept of SDG interactions is investigated both quantitively and qualitatively within a specific context. Firstly, qualitative methodology was adopted to enable the investigation of how different sustainable development goals interact with each other based on literature and expert interviews. Secondly, a quantitative methodology was adopted to structure and illustrate the identified interactions as a network of targets.

As Bornemann & Weiland (2021), Nilsson et al. (2016), Fader et al. (2019) and Weitz et al. (2017) pointed out SDG interactions are highly contextual. Therefore, a case study methodology was adopted. The choice of the regional scope of Kenya, the sectoral scope of dairy production and to take SDG2 as the point of reference was made for this thesis to contribute to a broader research program of Wageningen University and Research, with other Dutch, Kenyan and international organisations which is, amongst others, concerned with climate-smart livestock and SDG2 in Kenya.

In this mixed-method case study, SDG interactions in the chosen context are investigated within a two-step process. Step one includes the assessment of what interactions between the targets of SDG2 and fourteen other SDGs exist based on existing scientific literature. Step two includes the evaluation of the identified SDG interactions, by speaking to experts in the context to understand SDG interactions in practice. The conducted structured literature review served to identify context-specific SDG interactions, the interviews provided information on if and how these SDG interactions are perceived by experts in the field. Combing these two methods enabled the understanding of SDG interactions in theory and practice.

3.2 The context of dairy production in Kenya

As described in the conceptual framework, SDG interactions are highly contextual. This thesis investigates the interactions between SDG2 and other SDGs in the context of dairy production in Kenya. This section introduces the contextual background of dairy production in Kenya.

Economy

In Kenya, the livestock sector functions as a cornerstone for the economy and plays an important role in food security, livelihood and income for Kenyan households (Ashley, 2019). The Kenyan population is growing and therefore the demand for livestock products is increasing. The significant role of the livestock sector in the provision of food and employment, and the increasing demand for livestock products is the motivation by the Kenyan government and international development organisations to invest intensively in the livestock sector. Intensification and commercialization of the sector and the dairy sector in specific, are believed to contribute to the delivery of sustainable development in Kenya (Bosire et al., 2019). In 2010 the Kenya National Dairy Master Plan was published (Ministry of Livestock Development; 2010). The main focus of the plan was to improve the productivity and competitiveness of dairy products thereby '*improving standards of living of Kenyans by ensuring for farmers food security and increasing real incomes and productivity*' (Ministry of Livestock Development, 2010 p.1). The increased awareness regarding the vulnerability of the sector to the impacts of climate change and extreme weather events resulted in the development of the Kenya Climate Smart Agriculture Strategy (Government of the Republic of Kenya, 2017). The changing climate is accountable for, water stress, rising production costs, droughts, floods and reduced productivity of livestock leading to a loss of investments incomes and livelihoods (Government of the Republic of Kenya, 2017; Mainali et al., 2020). The strategy aims to develop interventions that make agriculture more resilient to climate change and minimise greenhouse gas emissions while producing sustainably to meet the growing demand for dairy products from the increasing population.

Ethnic groups

Kenya is an ethnically diverse country. Kikuyu, Luyha, Luo, Kalenjin and Kamba are the five largest ethnic groups and 'only' account for 65% of the Kenyan population (Poulton and Kanyinga, 2014). Poulton and Kanyinga (2014) point out that each ethnic group lives predominantly in one area of the country with specific geographical characteristics. Therefore, there is a strong link between a particular ethnic group and the agricultural value chain they are engaged with. For example, the Kalenjin, living in the Rift Valley, mostly produce maize and the Luos living around the Lake Victoria basin, are mostly engaged with cotton production. Dairy is mostly produced in the Central Rift highlands where mostly, Kikuyu, Kampa, Meru Nykia and Maasai live (World Population Review, 2022).

Dairy

The Kenyan dairy sector is dominated by smallholder farmers selling raw milk directly to consumers at informal markets or used for own consumption. In the smallholder farming system, milk handling is considered poorly with low compliance with safety and quality standards and a lack of energy sources (Galiè et al., 2021). Moreover, feed quality and quantity are considered inadequate, the costs of feed inputs are high and information on production approach and technologies is insufficient (Makau, et al., 2018b). Often women are responsible for the management of the animals and the men have the decision power over income and expenses (Galiè et al., 2021). Alongside smallholder dairy farmers, large commercial dairy farms exist in Kenya with more intensive dairy farming practices. Finally, in Kenya pastoralists' livestock systems are present, characterised by their nomadic or semi-nomadic lifestyle. In their practices, pastoralists rely on hunting and gathering in addition to herding. Therefore, the production of milk from cattle keeping is of secondary importance leaving the milk yields from pastoralist livestock systems limited and used for own consumption only (Boone and Lesorogol, 2016).

In general, the livestock sector and dairy production specifically is perceived as a sector with long working hours and low payments. This unattractive view of the livestock sector and the high entry barriers to start a dairy farm explain why youth is shifting away from agriculture and the relatively old age of the average dairy farmer (INT1, 2022; INT6, 2022; INT7, 2022).

SDG2: '*End hunger, achieve food security and improved nutrition and promote sustainable agriculture' comprises these challenges'* captures the challenges concerning food security and dairy production in Kenya, (United Nations, 2021). Therefore, this thesis puts SDG2 central in investigating interactions between the SDGs.

3.3 Assessing SDG interactions from literature

To answer RQ1, a structured literature review was performed. The existing interactions between SDG2 with fourteen other SDGs at the target level in the context of dairy production in Kenya were identified. In this analysis, SDG16 and SDG17 and their targets are discarded as they are related to the means of implementation. Pham Truffert et al. (2020) were able to reveal important blind spots while investigating SDG interactions investigation on the target level, as potential interactions among targets were not reported by the expert community when discussing SDG interactions at the goal level. Therefore, this study investigates SDG interactions at the target level.

3.3.1 Data collection

To collect relevant literature, a four-step selection process was followed. Figure 3 provides a flow diagram of the selection of literature for the structured literature review.

Step 1 includes the identification of literature by running search terms through Scopus. For each SDG, search words were defined based on the concepts used in the wording of the goal and its targets.

Subsequently, search terms were chosen to comprise the context, 'dairy production in Kenya'. All search words are provided in Table 1. Moreover, a date range of 2012-2022 was chosen to limit the number of results so it would be manageable to review all results. Using the developed search words, separately, fourteen search terms were inserted in the search engine Scopus to retrieve literature for the fourteen different combinations, SDG2 with fourteen other SDGs. Appendix I contains all used search terms and the dates on which they are used. By entering these fourteen search words 370 results were generated. Of these 370 results, 98 results appeared in multiple search terms. In total 214 unique articles were collected using the fourteen different search terms. A list of all analysed outputs can be found in the supplementary material (Appendix I).

Step 2 includes the screening of the identified literature. For every search term, the results were selected based on their relevance to the literature review by reading the abstract. The selection criteria were that the article had to be concerned with; SDG2, the other SDG at hand and milk production in Kenya. Only if the result met these criteria the full text of the result was obtained.

Step 3 includes assessing the eligibility of the identified literature. Out of 184 identified literature results, the full text of 178 literature results was available.

Step 4 includes the analyses of the selected 178 literature results for SDG interactions.

Table 1: *Overview of search words*

	Search words
Regional context	Kenya OR Kenyan
Sectoral context	dairy OR cow OR cattle OR milk
SDG 1: End poverty in all its forms everywhere	poverty OR "basic needs" OR "decent living" OR "living wage" OR "resilience of the poor" OR "poor households" OR "poor farmers"
SDG2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity"
SDG3: Ensure healthy lives and promote well-being for all at all ages	"human health" OR "well-being" OR "maternal mortality" OR "neonatal mortality" OR epidemics OR malaria OR tuberculosis OR aids OR "premature mortality" OR "mental health" OR "drug abuse" OR alcohol OR "traffic accidents" OR "road accidents" OR "reproductive health" OR "family planning" OR "health coverage" OR mortality AND NOT "zoonotic disease" OR "animal health" OR "cow disease" OR "breast milk"
SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	education OR illiteracy OR university OR "childhood development" OR literacy OR numeracy AND NOT "breast milk"
SDG5: Achieve gender equality and empower all women and girls	"women empowerment" OR gender
SDG6: Ensure availability and sustainable management of water and sanitation for all	sanitation OR water
SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all	energy OR "electrification" OR electricity OR renewable OR gas OR solar OR coal OR wind OR biomass AND NOT "Energy uptake" OR "energy intake"
SDG8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	"economic growth" OR jobs OR "employment" OR "economic productivity" OR "modern slavery" OR "safe working environments" OR labour OR tourism OR lab or OR "resource efficiency" OR entrepreneurship
SDG9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	infrastructure OR "innovation" OR "sustainable industries" OR "industrialization"
SDG10: Reduce inequality within and among countries	"inequality" OR "vulnerable populations" OR "political inclusion" OR "equality" OR "enhanced representation" OR migration OR "mobility of people" OR "income growth" OR "social inclusion" OR "economic inclusion" OR empowerment OR representation
SDG11: Make cities and human settlements inclusive, safe, resilient and sustainable	cities OR urbanization OR city OR housing OR slums OR "public transport" OR road OR "natural heritage" OR "cultural heritage" OR "public spaces" OR "green spaces"
SDG12: Ensure sustainable consumption and production patterns	"responsible consumption" OR "responsible production" OR "sustainable consumption" OR "sustainable production" OR "natural resources" OR waste OR "public procurement" OR "sustainable practices" OR "sustainable development" OR chemicals
SDG13: Take urgent action to combat climate change and its impacts	"climate change" OR "climate resilience" OR "natural disasters"
SDG14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	"coastal ecosystems" OR overfishing OR marine OR oceans OR sea OR seas OR ocean
SDG15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	"land management" OR deforestation OR desertification OR degradation OR ecosystems OR conservation OR biodiversity

Selection of literature using Scopus

Step 1

Literature found via running search terms in Scopus: N=370

SDG	Results	SDG	Results
1	18	9	14
3	43	10	15
4	40	11	28
5	18	12	32
6	44	13	21
7	28	14	3
8	28	15	38

Unique results: 214

Records appeared in multiple: 98

Excluded (n= 186) Not meeting criteria

SDG	Excluded	SDG	Excluded
1	5	9	4
3	21	10	6
4	18	11	19
5	6	12	20
6	27	13	7
7	24	14	3
8	12	15	14

Step 2

Title and abstract screened (n = 370)

Step 3

Included and searched for full text (n = 184)

SDG	Included	SDG	Included
1	13	9	10
3	22	10	9
4	22	11	9
5	12	12	12
6	17	13	14
7	4	14	0
8	16	15	24

Full text of literature not available (n= 6)

SDG	Unavailable	SDG	Unavailable
1	1	9	0
3	1	10	0
4	1	11	0
5	0	12	0
6	1	13	0
7	0	14	0
8	1	15	1

Step 4

Full text obtained and analysed (n = 178)

Literature with implied/described SDG interaction(s) (n = 78, of which 58 unique articles)

SDG	Interaction identified	SDG	Interaction identified
1	5	9	5
3	5	10	2
4	13	11	0
5	5	12	4
6	8	13	9
7	2	14	0
8	7	15	13

Literature without implied/described SDG interaction (n =100)

SDG	No interaction identified	SDG	No interaction identified
1	7	9	5
3	16	10	7
4	8	11	9
5	7	12	8
6	8	13	5
7	2	14	0
8	8	15	10

Figure 3: Flow diagram of selection of literature results for structured literature review.
Note: Step 1 includes the identification of literature results. Step 2 includes the screening of identified literature results. Step 3 includes the assessment of the eligibility of screened literature results. Step 4 includes the analyses of selected literature results. (own representation)

3.3.2 Data analysis

The conceptual chapter provided an understanding of what type of interactions can exist between two SDG targets; synergy & trade-off and incoming or outcoming SDG2. Inspired by the methodology of analyses by Pham-Truffert et al. (2020), every result was analysed on its description or implication of an interaction between one of the targets of SDG2 with the other SDG at hand. Identified synergies and trade-offs indicate possible causality between two targets but do not infer a causal relationship between two targets (Mainali et al., 2018). A synergy implies simultaneously meeting several interests or objectives resulting from political intervention, private sector investment or a mix thereof, while a trade-off implies an intervention to meet one objective hampers the delivery of another objective.

An Excel file was used to manage the information of the selected results. For every result, data was collected and noted down in the Excel file on the features described in Figure 4. A network analysis was created using Gephi software to illustrate the interactions between SDG2 and the other SDGs. In network terms, the data in this study consists of ties (interactions) among nodes (targets of SDGs) (Pham-Truffert 2020). The ties were signed as positive interactions (synergy) and/or negative interactions (trade-off). Secondly, the ties are directed: outgoing SDG2 or incoming SDG2.

- Title
- Author(s)
- Year of publication
- Journal
- Aim of study
- If the result appeared in other search term (1=yes, 0=no)
- For every target of SDG2, if it was concerned with this target (1=yes, 0=no)
- For every target of the SDG at hand, if it was concerned with this target (1=yes, 0=no)
- If an interaction was described or implied (1=yes, 0=no)
- Directionality of the interaction (incoming SDG2 = I, outgoing SDG2 = O)
- Description of the interaction
- For every other SDG, if the article was concerned with this SDG (1=yes, 0=no)

Figure 4: List of characteristics on which data is collected for every result

By performing this analysis 85 interactions were identified. Table 2 and Table 3 provide an overview of the interactions between SDG2 and the fourteen other SDGs (Table 2) and the interactions per target of SDG2 (Table 3).

Table 2: Results of analyses of selected literature results for SDG interactions

SDG	Amount of interactions	Incoming SDG2	Outgoing SDG2	Of which synergies	Of which trade-offs	Cases where synergy and trade-off are identified*
1	6	3	3	5	1	0
3	5	0	5	5	0	0
4	10	8	2	9	1	1
5	6	4	2	4	2	0
6	8	4	4	5	3	0
7	2	2	0	2	0	0
8	10	5	5	7	3	1
9	4	4	0	4	0	0
10	3	3	0	3	0	0
11	0	0	0	0	0	0
12	7	4	3	6	1	0
13	7	6	1	6	1	0
14	0	0	0	0	0	0
15	17	5	12	13	4	3
Total	85	48	37	69	16	5

* The number of combinations of targets of SDG2 with targets of other SDGs, where both a synergy and trade-off were identified.

Table 3: Overview of interactions per target SDG2

Target	Amount of interactions	Incoming SDG2	Outgoing SDG2	Synergies	Trade-offs	Synergy and trade-off identified*
2.1	16	11	5	13	3	0
2.2	5	3	2	4	1	0
2.3	40	21	19	28	12	5
2.4	24	13	11	24	0	0
2.5	0	0	0	0	0	0
Total	85	48	37	69	16	5

* The number of combinations of targets of SDG2 with targets of other SDGs, where both a synergy and trade-off were identified.

3.4 Assessing SDG interactions in practice

The second step of this mixed-method case study was in the shape of semi-structured expert interviews to generate a contextualised in-depth view of the SDG interactions regarding milk production in Kenya. In these interviews, the identified interactions between SDG2 with other SDGs at the target level in the context of dairy production in Kenya were presented to experts. Subsequently, it was asked if the experts recognised these interactions from their experiences and if and how these interactions were addressed in the field. Unfortunately, due to the large number of interactions identified, it was impossible to discuss all interactions during the expert interviews. The choice was made to select three to four interactions per SDG to capture the full SDG framework. In cases where more than four interactions between the SDG at hand and SDG2 were identified, the most surprising, unexpected and striking interactions according to the

researcher were selected. In the result chapter, it is described clearly which interactions are and which interactions were not discussed during the expert interviews.

3.4.1 Data collection

In preparation for the expert interviews, an interview script was developed and discussed with the supervisor. The choice for a semi-structured interview set-up was made as the structured interview style component allows for the objective comparison of how experts perceive the identified SDG interactions. While at the same time, semi-structured interviews allow for the exploration of topics relevant to the particular respondent. The interview script can be found in Appendix II.

For the sampling of experts, emails were sent to organisations and individuals involved in commercial and non-commercial dairy production in Kenya or involved in the development of commercial and non-commercial dairy production in Kenya. In total 30 emails were sent to actors or individuals who met these criteria, of which 7 responded positively. Additionally, snowball sampling was used to identify experts. Yet, this did lead to more experts. In Table 4, an overview can be found of all interviewees (N=7). The aim to balance different types of actors also determined the selection of experts. The selection of interviewees includes one representative of the Kenyan government, a policy expert, three academic experts specialised in different aspects of livestock in Kenya, one manager of a conservancy, and one representative of an international NGO operating in Kenya. With their specific knowledge, experiences and position in the context, the experts provided insights on specific issue areas from various perspectives.

Table 4: Overview and description of experts

Name	Description	Date	Reference in analysis
Erick Omollo	Expert in range resource economics, (pastoral) livestock systems and resilient development in Kenya. - Engaged in the Kenya Climate Smart Agriculture Project (KCSAP).	25/02/2022	INT1
Todd Crane	Principal Scientist, Climate change adaptation at ILRI. - Engaged in the research programme for climate-smart livestock systems (PCSL project).	03/03/2022	INT2
X*	Manager of a Conservancy, Conservation biologist. - Engaged in a project regarding cattle management across conservancies.	04/03/2022	INT3
Harold Mate	Agribusiness expert. - Engaged in a project regarding investments in businesses working with smallholders to adopt climate-smart agricultural practices.	08/03/2022	INT4
Joel Onyango	Expert in research and management focussing on a. o. science technology and innovation; climate change adaptation and mitigation; food security - Engaged in a project regarding inclusive low emission dairy development.	11/03/2022	INT5
Bernard Kimoro	Head of the climate change and livestock sustainability section at the department of livestock of the Ministry of Agriculture, Livestock, Fisheries and Cooperatives.	11/03/2022	INT6

| Laura Cramer | Science Officer at CGIAR Climate Change, Agriculture and Food Security and PhD fellow at ILRI – Engaged in the research programme for climate-smart livestock systems (PCSL project). | 18/3/2022 | INT7 |

3.4.2 Data analysis

For data analysis of the conducted interviews, Excel was used. Firstly, the interviews were conducted and recorded using Microsoft teams and subsequently transcribed. The transcribed interviews were coded using the structure of the SDGs. The codes are listed in Table 5. Because of the large structured element in the semi-structured interviews, objective comparison of the answer of the different experts was ensured.

Table 5: Developed codes for coding interviews

Category	Description	Code
Introduction	Introduction	A
	Familiar SDGs	B
	Contributing to what SDGs	C
SDG2 – SDGX*	Yes, recognised interactions	X.1
	No, did not recognise interactions	X.2
	Description of other interactions	X.3
	How interaction is addressed	X.4
Ranking SDG interactions	1st place	R1
	2nd place	R2
	3rd place	R3
	4th place	R4
	5th place	R5
Governance	What is needed to better address SDG interactions	G

For all SDGs (SDG1, SDG3-SDG15) specific codes were developed.

3.5 Limitations

Due to the time scope and reach of this thesis, this thesis entails some limitations. This thesis is concerned with assessing the interactions between SDGs within a very specific context. Additionally, very limited exploration of how these interactions should be governed is provided. This thesis should be considered a primary investigation as this thesis assessed what SDG interactions exist in a specific context. The identification of these interactions allows for the investigation of how to govern these interactions. The chosen methodological approach does entail some limitations. This part of the methodological chapter shortly discusses some limitations of the chosen methodology.

Firstly, SDG interactions were investigated in a very narrow context. Secondly, only the interactions between SDG2 and other SDGs were investigated and interactions between other SDGs were

outside the scope of this thesis. Thirdly, in conducting the structured literature review, only one source bank, Scopus was used. Additionally, a time frame of 10 years 2012-2022 was implemented to narrow down the number of results. This gives the chance of relevant articles being left out. Fourthly, the limited time resulted in only a handful of interviews with experts in the field. During these interviews, only a selection of all identified interactions was discussed due to time constraints. Therefore, the results of this study only provide a partial understanding of SDG interaction within this context and no general conclusions should be made.

In addition, a limitation occurs in the interviewee collecting process as this study is dependent on the willingness to cooperate in these interviews by contacted potential interviewees. Therefore, the set of experts might not be represented and does not include all views and perceptions regarding SDG interactions by all actors in the context.

Specifically, the identification of interactions in the structured literature review entails three limitations. Firstly, the identification of interactions is not solely based on stated interactions but also on implied interactions between targets. This could be overcome by letting the identification process be conducted by multiple individuals. Yet, as this is a master thesis, only one researcher was responsible for the interpretation of the results for drawing conclusions.

Secondly, no scoring assessment was performed to code the interactions. Nilsson, Griggs & Visbeck (2016) developed a scoring table of the nature of interactions between SDGs. The typology ranges from cancelling (-3) to indivisible (+3). Some interactions are indivisible or cancel each other by definition (Le Blanc, 2015). By applying this scoring matrix, a distinction can be made between the different intensities of SDG interactions. This typology has been applied by several studies and policy documents investigating SDGs interactions (ICSU, 2017; Pham-Truffert et al., 2020; Weitz, et al., 2014; Le Blanc, 2015; Mainali et al., 2018; Institute for Global Environmental Strategies, 2017). The reason for not applying this typology in this study is attributable to only one individual conducting the interpretation of the results and identification process. Yet, this results in all interactions between targets being thrown in the same pot while they might differ by intensity.

Thirdly, due to performing this study in a narrow context, identified interactions in most cases only were implied by one or two articles. The outlier is implied by seven articles. Taking a broader context would result in more articles and therefore, it is likely that interactions would be implied by more articles. As stated above, the limited time available forced the researcher to take a narrow context. The advantage of taking a more narrow context is that it allows the researcher to better understand SDG interactions in this context as they are highly contextual.

Chapter 4: Empirical chapter

This chapter presents the empirical results of this study. Firstly, the results of a structured literature review are presented to obtain an overview of what interactions between the targets of SDG2 with fourteen other SDGs exist in the context of commercial and non-commercial milk production and consumption in Kenya. Secondly, the chapter presents how experts rank SDG interactions on the importance to address these. Thirdly, the chapter present what according to experts is needed to better govern SDG interactions. The chapter ends with an overview of the results.

4.1 Identified interactions between SDG2 and other SDGs

To gain an insight into what interactions between the targets of SDG2 with fourteen other SDGs exist regarding dairy husbandry in Kenya, a structured literature review is performed. SDG2 is concerned with ending hunger, achieving food security and improving malnutrition and promoting sustainable agriculture. The goal includes 5 targets which are described in Table 6.

Table 6: *SDG2 and targets*

SDG2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture
2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.
2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.
2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.

Source: United Nations (2015)

When using the fourteen developed search terms 370 document results appeared, of these 370 results, 184 were selected based on the relevance to the specific SDG and milk production in Kenya (Appendix 3). By analysing the results for interactions between the targets of SDG2 and the SDG at hand, 85 interactions were identified between SDG2 and the other SDGs.

Figure 5 illustrates all 85 interactions between SDG2 and the other SDGs in the context of dairy production in Kenya. The remainder of this chapter presents all individual interactions between SDG2 and other SDGs in detail. For every combination with SDG2 with the other SDGs, the particular SDG, its targets and the identified interactions with the targets of SDG2 resulting from the structured literature review are discussed. Additionally, a description of how interviewed actors perceive these interactions, based on the semi-structured interviews, is provided.
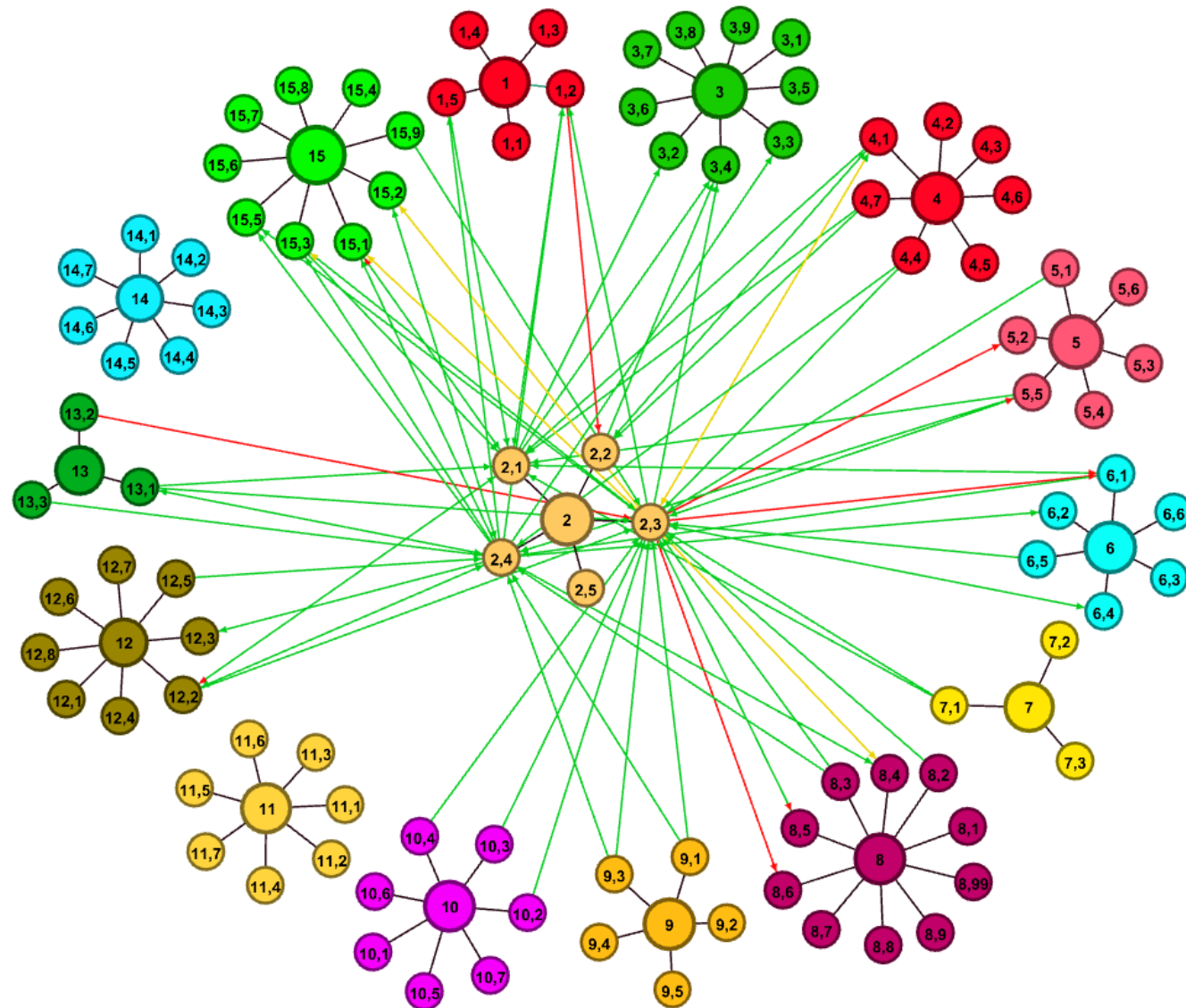
Figure 5: Illustration of interactions between SDG2 and other SDGs. (own representation)
Green arrows represent a synergetic relationship. Red arrows represent a trade-off. Yellow arrows indicate both synergy(s) and trade-off(s).

Interactions SDG2: 'Zero Hunger' & SDG1: 'No Poverty'

SDG1 is concerned with ending poverty in all its forms everywhere and has five targets which are described in Table 7.

Table 7: *SDG1 and targets*

SDG1 End poverty in all its forms everywhere	
1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day
1.2	By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions
1.3	Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable
1.4	By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance
1.5	By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

Source: United Nations (2015)

Interactions from literature

By analysing the 12 articles, five synergies and one trade-off were identified between the targets of SDG1 and SDG2 in the context of milk production in Kenya. The interactions between SDG1 and SDG2 are illustrated in Figure 6. Taking SDG2 as the point of reference, three interactions are incoming and three interactions are outgoing. Thus for three targets, efforts to achieve SDG1 were found to contribute to or impede the achievement of SDG2. For three targets, efforts to achieve SDG2 were found to have co-benefits to the achievement of SDG1. The identified interactions for each target are listed in Table 8. A more elaborate description can be found in Appendix 4.

Figure 6: *Interactions between SDG1 'End poverty in all its forms everywhere' & SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (own representation).*

Table 8: *Description of identified interactions between SDG2 and SDG1*

#*	Direction**	Description
S1a	Incoming	Several studies describe that in cases of increases in income among poor households (1.2), total expenditure on food items increased and specifically expenditure on milk and milk products and thereby improving food security (2.1).
T1a	Incoming	The demand for women's time and workload increases when farming households aim to increase income by increasing production and productivity (1.2). This, in some cases results in women introducing water or cow's milk into their child's diet at an earlier age which is concerning as infants 'digestion systems are not mature enough to process liquids other than breast milk (2.2).
S1b	Incoming	When farmers reduce their vulnerability to climate-related extreme events by improving their ability to cope and recover from shocks (1.5), farmers can sustain or even improve food security (2.1) as income is secured and there are fewer production losses due to resilience.
S1c	Outgoing	The increase in milk yields leads (2.3) to increases in income and thereby reduction of poverty (1.2) .
S1d	Outgoing	Due to the adoption of resilient agricultural practices by farmers and ensuring sustainable food production systems (2.4) poverty levels of these farming households were found to be reduced (1.2).
S1e	Outgoing	Diversification of livestock (2.4) strengthens livelihood resilience through improved ability to cope and recover from shocks (1.5).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

During the interviews, interactions S1a, T1a, S1c and S1d were discussed. Experts recognised these interactions. Experts pointed to the importance of agriculture in the Kenyan economy and on household livelihood systems as agriculture employs most of the populations in rural setups. Several experts emphasise the importance of different contexts and making the distinction between commercial and subsistence milk production (INT1, INT4, INT5). INT1 only recognizes interaction 1b in the context of subsistence milk production. INT5 only recognizes interaction 1a in the context of commercial and more structured market systems. When thinking of a subsistence dairy farmer, a farmer might have to choose between generating enough financial resources to not be poor or having enough food to be food secure, implying a trade-off between SDG1 and SDG2. Furthermore, INT4 and INT6 point out that sometimes one could be reducing extreme poverty but actually not achieving food security as in Kenya when incomes increase, people move away from nutritious foods to less nutritious foods. By doing so, they imply another trade-off between reducing poverty levels (1.2) and achieving food security (2.1).

Interactions SDG2: 'Zero Hunger' & SDG3: 'Good Health & Well-being"

SDG3 is concerned with ensuring healthy lives and promoting well-being for all, at all ages and consists of nine targets which are described in Table 9.

Table 9: SDG3 and targets

SDG3 Ensure healthy lives and promote well-being for all at all ages	
3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births
3.2	By 2030, end preventable deaths of new-borns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births
3.3	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases
3.4	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
3.5	Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol
3.6	By 2020, halve the number of global deaths and injuries from road traffic accidents
3.7	By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes
3.8	Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all
3.9	By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

Source: United Nations (2015)

By analysing the 21 articles, five synergies were identified between the targets of SDG3 and SDG2 in the context of milk production in Kenya. The interactions between SDG3 and SDG2 are illustrated in Figure 7. Taking SDG2 as the point of reference, all five interactions were outgoing. Thus, efforts to achieve SDG2 were found to have co-benefits to the achievement of SDG3. The identified interactions for each target are listed in Table 10. A more elaborate description can be found in Appendix 4.
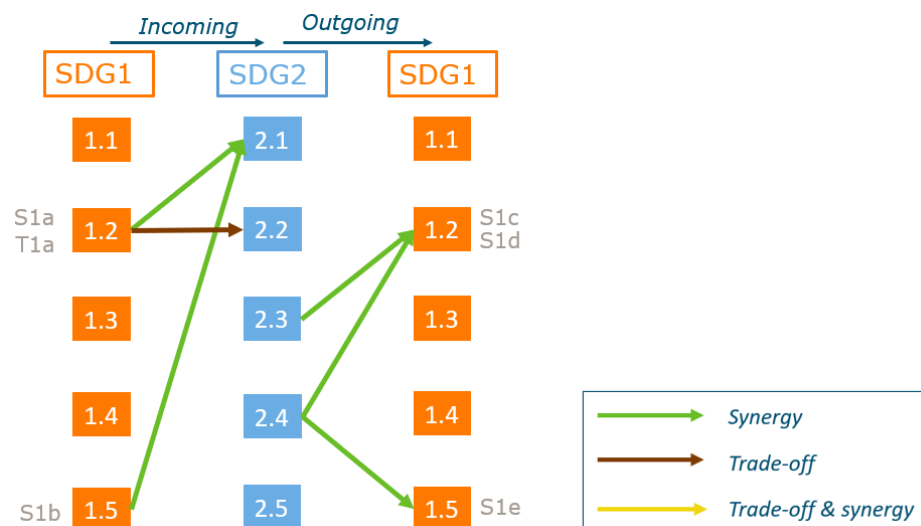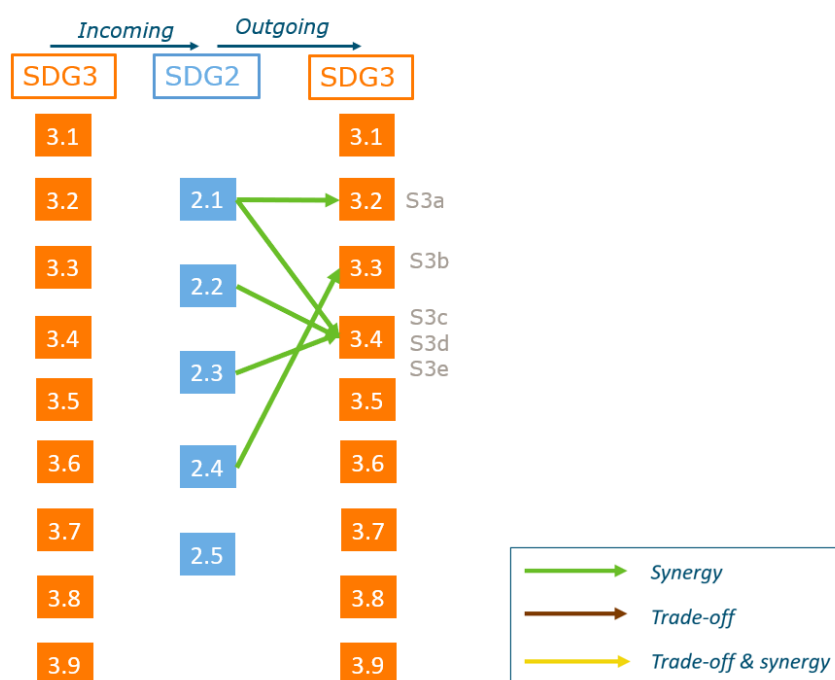

Figure 7: Interactions between SDG3 'Ensure healthy lives and promote well-being for all at all ages' & SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (own representation).

Table 10: Description of identified interactions between SDG2 and SDG3

#*	Direction**	Description
S3a	Outgoing	In this case, the consumption of unsafe milk (2.1), aflatoxin-contaminated food, results in child malnutrition and child diseases. Improving the quality of milk consumed contributes to ending deaths of new-borns and children < 5 y/o (3.2).
S3b	Outgoing	An enhanced surveillance system functioned as an early warning system that could defect Rift Valley Fever (RVF) epidemics in Eastern Africa, making livestock practices more resilient (2.4). Simultaneously, it contributes to ending epidemics and communicable diseases (3.3).
S3c	Outgoing	When people consume contaminated dairy from animals which ate contaminated feed, people (2.1) are exposed to aflatoxins. Exposure to aflatoxins is associated with an increased risk of cancer. Efforts to improve the quality of dairy consumed contribute to reducing premature mortality (3.4).
S3d	Outgoing	Attempts to end malnutrition (2.2) through a nutrition education intervention, were found to contribute to the achievement of target (3.4), ending premature mortality and improving well-being.

S3e	Outgoing	Maintaining or increasing productivity (2.3) by means of preventing conflicts between pastoralist livestock with wildlife are likely to simultaneously contribute to the achievement to improve well-being (3.4).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S3b, S3c and S3d were discussed. Experts did recognize all these interactions and expressed the importance of the first 1000 days of a child. One expert (INT6) brought up that children develop better mentally if they are well fed and therefore communities and households where milk is consumed, issues regarding mental health are minimal. Another expert mentioned the relatively little attention to mental health issues in Kenya and Sub-Saharan Africa. Furthermore, the expert described that the synergies between ending malnutrition and ending premature mortality and improving well-being are utilised by providing school feeding programs.

Interactions SDG2: 'Zero Hunger' and SDG4: 'Quality Education'

SDG4 is concerned with ensuring inclusive and equitable quality education and promoting lifelong learning opportunities and consists of seven targets which are described in Table 11.

Table 11 SDG4 and targets

SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	
4.1	By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes
4.2	By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education
4.3	By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university
4.4	By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship
4.5	By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations
4.6	By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy
4.7	By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development

Source: United Nations (2015)

By analysing the 21 articles, ten interactions were identified between the targets of SDG4 and SDG2. Of these interactions, 9 are synergies and 1 is a trade-off. The interactions between SDG4 and SDG2 are illustrated in Figure 8. The majority of interactions, seven, were incoming interactions. Two interactions were outgoing. The targets 4.1 and 2.2 and 4.1 and 2.3 are interacting in both ways. The identified interactions for each target are listed in Table 12. A more elaborate description can be found in Appendix 4.
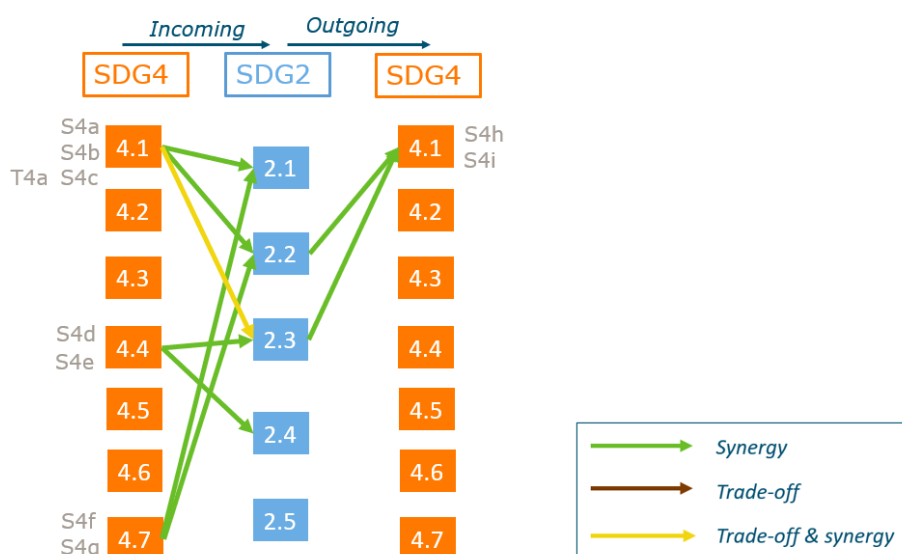
Figure 8: *Interactions between SDG4 'Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all' & SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (own representation).*

Table 12: *Description of identified interactions between SDG2 and SDG4*

#*	Direction**	Description
S4a	Incoming	A link exists between the level of education completed by the women (4.1) and the intake of nutrients within rural households (2.1).
S4b	Incoming	An increase in the level of education completed (4.1) is linked with improved knowledge of nutrition and will contribute to the achievement of ending malnutrition (2.2).
S4c	Incoming	A link between completing secondary education (4.1) and average daily weight gain of calves, increased productivity (2.3) was identified.
T4a	Incoming	A farmer who completed higher education (4.1) had calves with a lower average daily weight gain (2.3), due to the farmers' involvement in off-farm activities.
S4d	Incoming	The education of cell phone technology tools in dairy farming to farmers (4.4), was found to increase agricultural productivity (2.3)
S4e	Incoming	When the level of relevant skills for employment increases (4.4), dairy farmers are more likely to adopt resilient agricultural practices (2.4).
S4f	Incoming	Education on sustainable development and lifestyle (4.7) improves understanding of zoonotic diseases in Kenya. This is likely to result in the provision of more productive and safe food and thus more productive and safe milk provision (2.1).

S4g	Incoming	Providing nutritional education (4.7) among pastoral women with low education may help overcome unhealthy food taboos and improve dietary practices of pregnant women and their new-borns (2.2).
S4h	Outgoing	For undernourished children, increased consumption of milk and other animal source foods (2.2), improves anthropometric indices, cognitive function and school performance (4.1), while reducing morbidity and mortality.
S4i	Outgoing	Incidences of increased agricultural productivity of smallholder farmers (2.3) allowed for an increase in expenditure on school fees, resulting in more girls attending school (4.1).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S4a, S4c, T4a and S4f were discussed. Six out of seven experts recognised all interactions. One expert questioned that being able to access education improves food security (INT4). Two experts voiced that they expected that, alongside a synergetic relationship between target 4.1 incoming target 2.2, there would also be a synergy outgoing target 2.2 to target 4.1. This is in line with synergetic interaction (S4h), which was not discussed in the interviews. Four experts reported the challenge of youth moving away from agriculture and mentioned the long working days and little profit made as a reason for its attractiveness. Additionally, it was mentioned that for youth it is hard to possess sufficient resources to start a farm. Older people often do have the means to do so and therefore the sector consists of relatively older people. Experts did mention that youth is still involved in food chains and the agricultural sector by, amongst others, providing transportation of milk or inputs. While the majority of experts framed the issue of youth moving away from agriculture as a challenge, one expert did not perceive this as a bad thing. The expert saw the trend as people looking for opportunities. Resulting from youth moving away from agriculture into other jobs, remittances are sent from this group to their rural families to enable their family to invest in technical upgrades. Lastly, two experts (INT2 and INT3) pointed out that for some dairy farmers, their farm is a hobby farm and provides a secondary income stream. These farmers are not as intended to it and are therefore not as productive or efficient.

Three experts mentioned the efforts made to address youth moving away from agriculture (T4a). INT1 and INT6 pointed out that trainings for relevant skills are provided and efforts are made to make agriculture an enabling environment. Yet, INT1 perceives the lack of proper structural systems and institutions which support agriculture as businesses as the problem of why youth is still moving away from agriculture. Additionally, INT4 mentions the many resources needed to start producing in agriculture as the problem, and mentions how youth is involved in agriculture as services provision, collecting, transporting and providing trainings. Interaction 4a is being addressed by sub-national governments by providing school feeding programs, and school-level education on agriculture (INT1).

SDG5 is concerned with achieving gender equality and empowering all women and girls, and consists of six targets which are described in Table 13.

Table 13: SDG5 and targets

SDG5 Achieve gender equality and empower all women and girls	
5.1	End all forms of discrimination against all women and girls everywhere
5.2	Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation
5.3	Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation
5.4	Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate
5.5	Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life
5.6	Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Program of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences

Source: United Nations (2015)

Interactions from literature

By analysing the 12 articles, three synergies and two trade-offs were identified between the targets of SDG5 and SDG2. All interactions incoming SDG2 are synergies, while all interactions outgoing SDG2 are trade-offs. The interactions between SDG5 and SDG2 are illustrated in Figure 9. The identified interactions for each target are listed in Table 14. A more elaborate description can be found in Appendix 4.
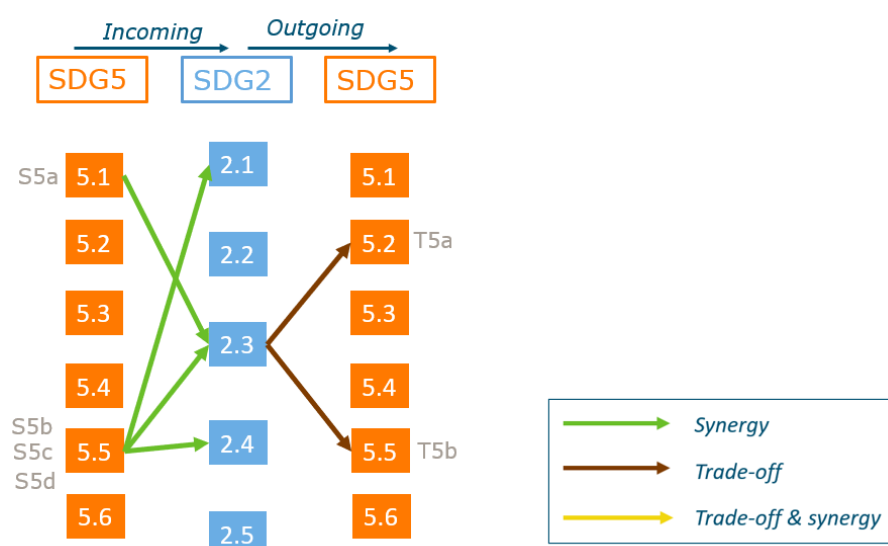
Figure 9: *Interactions between SDG5 Achieve gender equality and empower all women and girls & SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (own representation).*

Table 14: *Description of identified interactions between SDG2 and SDG5*

#*	Direction**	Description
S5a	Incoming	Kenyan women are found to suffer more constraints in the livestock sector (5.1) resulting in lower incomes for female farmers (2.3).
S5b	Incoming	It was found Kenyan rural women possess sufficient knowledge regarding nutritious diets, but lack the agency to make decisions and put their knowledge into practice. Thus, improving women's limited decision-making (5.5) power regarding milk purchase contributes to achieving food security by being able to provide sufficient milk (2.1).
S5c	Incoming	If rural Kenyan women have equal access to production resources and services as men (5.5), they can increase production on their farms by 20-30% (2.3).
S5d	Incoming	The limited responsibility, access and control women have over land, labour and financial resources (5.5) results in low incentives in uptake and intensification in the utilisation of climate-smart agriculture (2.4).
T5a	Outgoing	Women have to 'lie low' as their men don't appreciate the successes of women (increases in agricultural productivity) (2.3) and in some cases, this envy occurs in the form of domestic violence (5.2).
T5b	Outgoing	For rural Kenyan women, joining producer organisations increases access to markets and technologies and commercialization occurs (2.3), this leads to the disempowerment of women as men take over control of the farm (5.5).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S5b, S5c and T5a were discussed. All experts confirmed they recognize or have experienced the discussed interactions. Regarding interaction S5b, INT6 mentioned that he experienced households with equal opportunities for participation of women and decision making, security is achieved, and that in a project they are utilising this synergy to contribute to SDG5 & SDG2. INT2 mentioned a caveat that there are quite a number of studies of different places that see increased commercialization decreasing nutritional security. This is the case because once milk becomes a commodified product and cash comes through farming households, less milk is used for the households, instead, they use money to buy maize meal which is pure starch and calories but less nutritious compared to milk. Thus, according to INT2, when commercialization can occur due to the provision of equal opportunities to women, one should keep in mind that this can result in a trade-off with the quality of nutrients consumed by the farming household.

All experts elaborately confirmed interactions T5b and in some (INT4, INT5 & INT6) how increases in income from farming might result in conflict and violence (T5a). INT1 described the nature of ownership of who has, and takes control of family resources. In Kenya, very often the man is the head of the household. Regarding small holder dairy production, INT4 mentioned that if valuation doesn't come, men tend not to be interested. But if valuation occurs and can be commercialized, then men become interested in that the valuation with incidences of conflict as result. INT6 described that in some cases, the increase in income is used to buy alcohol, and that brings in some violence. He noted that this is not something that cuts across all communities, but a specific region. Several experts explained how this trade-off is addressed.

INT1 mentioned that gender elements are considered in several research projects. INT2 described a project which experimented with a social and technical intervention in the form of an alternative payment model and household-based engagement. Furthermore, INT2 expressed the lack of effort to address T5b from policy spheres. INT7 did describe, how in her view, the Ministry of Agriculture has a 'pretty strong' commitment to gender equality and how the constitution has built-in gender rules within the legislature and other institutions but is unsure if gender issues are addressed within the dairy sector specifically. INT4 explains that in the projects he is engaged with, T5b is addressed but T5a is not. Equal opportunities for women are provided but not in terms of a gender-based violence and discrimination act. INT5, INT6 and INT7 all describe the importance of including men in providing equal opportunities for women to address this trade-off. Instead of enhancing opportunities for women, one should enhance the opportunities for the communities, thereby building a stronger household. INT6 described that this was done in a project by transformative gender methodologies where a visioning process and household planning were implemented. INT7 was engaged in a similar project and currently, INT5 is engaged in a project to ensure equal opportunities for both men and women in marine aquaculture. Lastly, INT3 described how for the management of rangelands they chose to remove sheep from the conservancy. Let alone, sheep are very often managed by women and function as a source of income by them. Although women in the conservancy shifted to milking cows and cattle keeping, INT3 wonders if it was a good decision, if they should have started investing in better management practices of sheep and thereby still allowing for sheep keeping in the conservancy.

Lastly, INT5 described how he expects another synergy between ending discrimination and violence and achieving food security as in cases of domestic violence, the food security of the household is affected.

Interactions SDG2: 'Zero Hunger' and SDG6: 'Clean Water and Sanitation'

SDG6 is concerned with ensuring availability and sustainable management of water and sanitation and consists of six targets which are described in Table 15.

Table 15: SDG6 and targets

SDG6 Ensure availability and sustainable management of water and sanitation for all	
6.1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all
6.2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
6.3	By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
6.4	By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
6.5	By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6	By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

Source: United Nations (2015)

Interactions from literature

By analysing the 11 selected articles, five synergies and three trade-offs were identified between the targets of SDG6 and SDG2. The interactions between SDG6 and SDG2 are illustrated in Figure 10. Four synergies are incoming SDG2, three trade-offs and one synergy are outgoing SDG2. Targets 2.1 & 6.1 are interacting both ways. The identified interactions for each target are listed in Table 16. A more elaborate description can be found in Appendix 4.
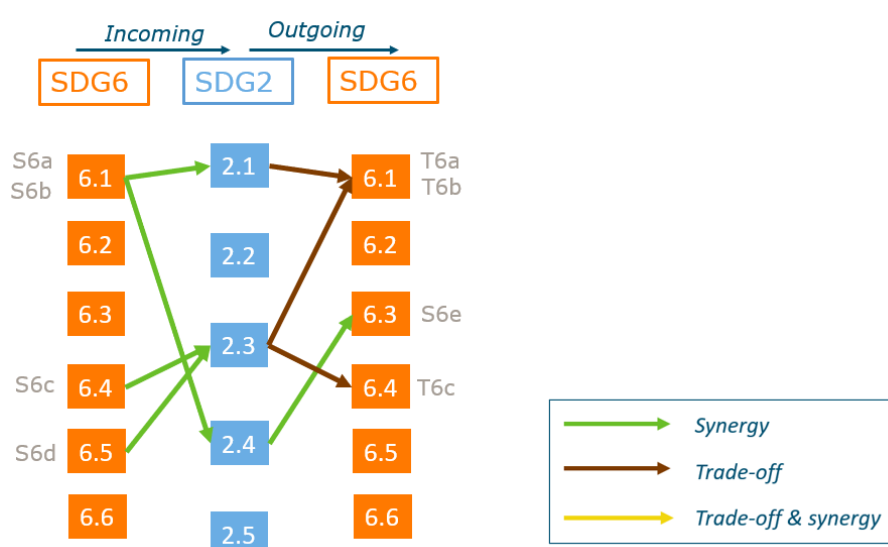
Figure 10: *Interactions between SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' & SDG6 'Ensure availability and sustainable management of water and sanitation for all' (own representation).*

Table 16: *Description of identified interactions between SDG2 and SDG6*

#*	Direction**	Description
S6a	Incoming	Due to water scarcity (6.1), farmers in the Oljoro-Orok region used water containing liver fluxes in the milk handling process and sanitation in the dairy environment resulting in contaminated milk (2.1).
S6b	Incoming	The availability and accessibility of water, e.g. in the form of a well (6.1) enables the adoption of resilient and sustainable agricultural practices (2.4).
S6c	Incoming	Ensuring water-use efficiency (6.4) will be likely to increase agricultural productivity (2.3), as the water footprint per unit of milk produced is improved.
S6d	Incoming	The adaptation of appropriate land and water resource management (6.5) increases milk production from 6 to 11 litres per cow per day respectively (2.3).
T6a	Outgoing	The Kenyan population, especially the middle class, is expected to grow and therefore the demand for dairy products is expected to increase (2.1). The production process of these products puts more pressure on water sources (6.1).

T6b	Outgoing	Water used for increasing milk production near Nairobi (2.3) is water which highly competes with other claims for water such as water to be consumed as drinking water (6.1).
S6e	Incoming	Unsustainable milk production practices (2.4) generate greenhouse gases and pollute the water (6.3).
T6c	Incoming	Efforts to increase milk production (2.3) demand high levels of water and thus put more pressure on water resources and contribute to water scarcity (6.4).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S6a, S6c, S6e and T6a were discussed. The discussed interactions were not widely recognised nor refuted. In general, experts expressed that unavailability of water is an issue in Kenya, especially in the drylands, as the country is a water deficit country and the issue of competing claims for water (INT3, INT5, INT6). INT5 recognised interactions S6a and the importance of safe drinking water to nutrition security and health outcomes specifically.

Regarding interactions S6c, INT2 noted that there might be an interaction the other way around. He mentions the example of biodigesters on intensive dairy farms which require substantial water input daily. This implied trade-off corresponds with the undiscussed identified interaction between target 2.3 and 6.4, T6f.

INT4 confirmed interaction S6e and how sustainable practices and protecting the environment and lands could lead to the availability of safe drinking water as fewer chemical sand fertilizers are used.

INT5, INT6 and INT7 recognised the issue regarding the growing Kenyan population and pressure on water sources. When discussing interaction T6a, INT5 expressed how food production can have quite negative effects on safe and affordable drinking water and how one ends up spending a lot of resources to clean water before it is considered safe. In the activities he is engaged with, not a lot of emphasis is put on water-related issues (SDG6) as it is focused to ensure economic growth and social protection and well-being.

Lastly, INT6 described the synergy S6b, and how the availability of water enables the implementation of irrigation and more sustainable agricultural practices.

Interactions SDG2: 'Zero Hunger' and SDG7: 'Affordable and clean energy'

SDG7 is concerned with ensuring access to affordable and sustainable energy and consists of three targets which are described in Table 17.

Table 17: SDG7 and targets

SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all	
7.1	By 2030, ensure universal access to affordable, reliable and modern energy services

| 7.2 | By 2030, increase substantially the share of renewable energy in the global energy mix |
| 7.3 | By 2030, double the global rate of improvement in energy efficiency |

Source: United Nations (2015)

Interactions from literature

By analysing the identified 4 articles, two synergies were identified between the targets of SDG7 and SDG2. The interactions between SDG7 and SDG2 are illustrated in Figure 11. The two synergies were directed from SDG7 incoming SDG2. Subsequently, the identified interactions for each target are described in Table 18. A more elaborate description can be found in Appendix 4.

Figure 11: *Interactions between SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' & SDG7 'Ensure access to affordable, reliable, sustainable and modern energy for all' (own representation).*

Table 18: *Description of identified interactions between SDG2 and SDG7*

#*	Direction**	Description
S7a	Incoming	In commercial Kenyan dairy farming, the lack of energy access (7.1) results in poor milk cooling and handling. This poor milk cooling and handing results in poor quality dairy products (2.1).
S7b	Incoming	A lack of energy access (7.1) results in insufficient milk cooling systems which forces Kenyan dairy farmers to sell their milk cheaply before the milk spoils for lower prices (2.3).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S7a and S7b were discussed. During the expert interviews, interaction S7a was not recognised nor refuted. Experts (INT4 & INT6) did mention how the lack of energy and proper cooling practices results in food losses. INT4 and INT5 recognised how these post-harvest losses due to the

lack of access to energy, result in lower incomes of farmers (interaction S7b). INT5 described the high prices of energy in Kenya. Furthermore, he described how a project is utilising this synergy and addressing the high energy prices by installing solar energy panels for dairy cooling systems.

INT2 and INT3, brought up charcoal burning of rural households as an alternative for energy and firewood and the negative effects on health. No interaction was implied in this context between SDG7 and SDG2.

Interactions SDG2: 'Zero Hunger' and SDG8: 'Decent Work and Economic Growth'

SDG8 is concerned with promoting sustained, inclusive and economic growth and decent work for all. SDG8 consists of ten targets which are described in Table 19.

Table 19: SDG8 and targets

SDG8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors
8.3	Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services
8.4	Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead
8.5	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value
8.6	By 2020, substantially reduce the proportion of youth not in employment, education or training
8.7	Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms
8.8	Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment
8.9	By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products
8.10	Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all

Source: United Nations (2015)

Interactions from literature

By analysing the identified 15 articles, seven synergies and four trade-offs were identified between the targets of SDG8 and SDG2. The interactions between SDG8 and SDG2 are illustrated in Figure 12. Four synergies were incoming SDG2. Two synergies and three trade-offs were outgoing SDG2. The targets 8.5 &

2.3 and 8.4 & 2.4 are interacting both ways. The identified interactions for each target are listed in Table 20. A more elaborate description can be found in Appendix 4.
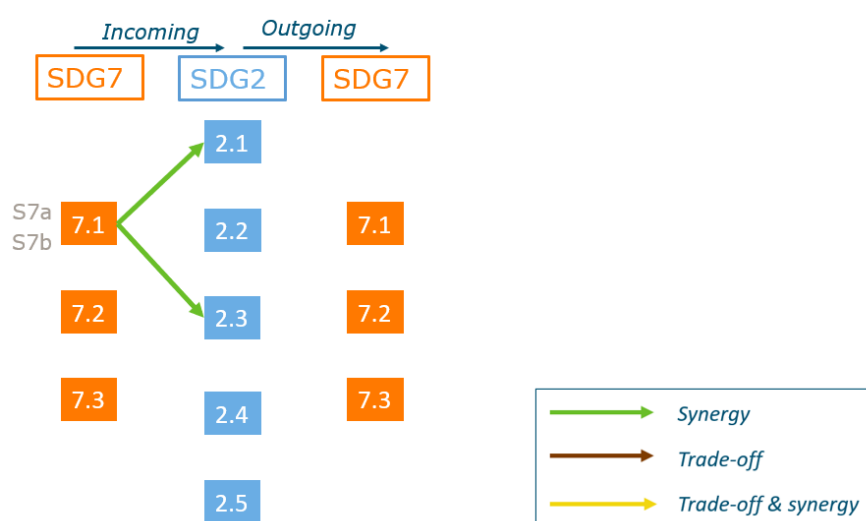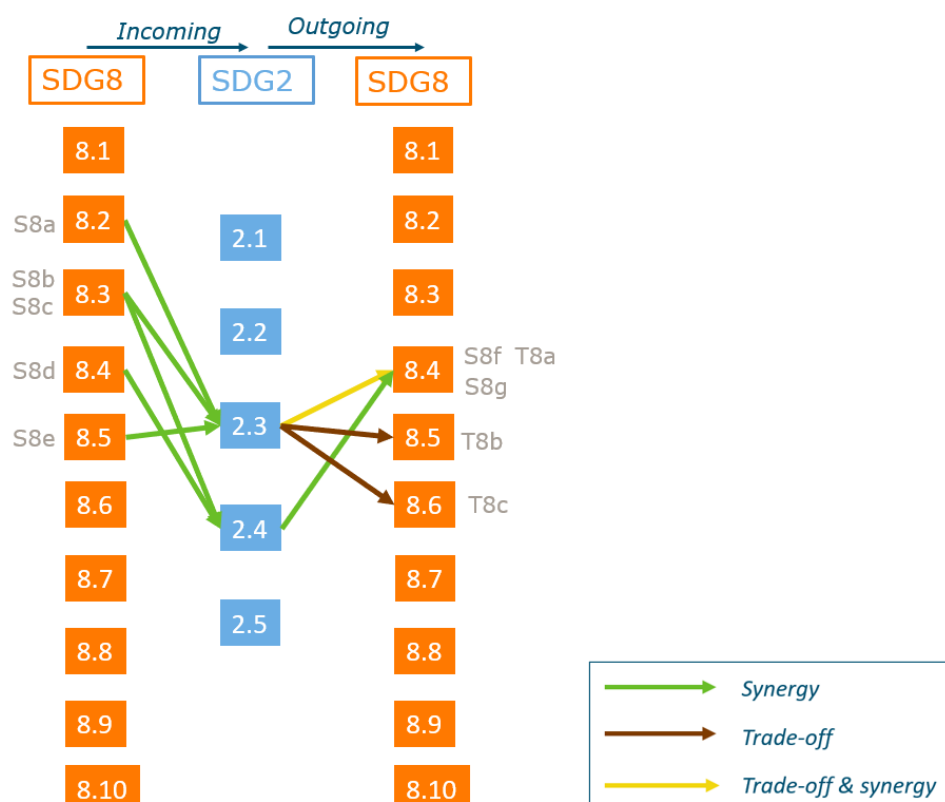

Figure 12: *Interactions between SDG8 'Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all' & SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (own representation).*

Table 20: *Description of identified interactions between SDG2 and SDG8*

#*	Direction**	Description
S8a	Incoming	Adopting tightly bunched herding (8.2) improves cattle performance and the financial benefit of improved cattle performance offsets the costs of the investment to implement tightly bunched herding (2.3).
S8b	Incoming	In Kenya, young men and women lack access to land and capital to enter dairy production. Youth-specific self-help groups which help overcome constrained access to land and capital as well as provide technical trainings (8.3) were found to contribute to improve agricultural production & secured equal access to land (2.3).
S8c	Incoming	Increasing knowledge and entrepreneurial skills of farmers as technical and managerial improvements are needed (8.3), in order to realize the transition to more sustainable and resilient agri-food systems (2.4).
S8d	Incoming	Improving global resource efficiency (8.4) in production results in more sustainable food production systems (2.4).
S8e	Incoming	Regarding women on milk markets, ensuring equal pay of work of equal value (8.5) increase income of female smallholder dairy farmers (2.3).
S8f	Outgoing	Achieving doubling agricultural productivity (2.3) by means of intensification of the dairy sector in some cases contributes to the delivery of global resource efficiency (8.4) as these practices do, in some cases make better use of water and land resources.

T8a	Outgoing	Achieving doubling agricultural productivity (2.3) by means of intensification of the dairy sector in some cases hampers delivering global resource efficiency (8.4) as these practices do not in all cases make best use of water and land resources.
S8g	Outgoing	When more sustainable food production systems are in place (2.4) this contributes to the delivery of improving global resource efficiency (8.4).
T8b	Outgoing	In case of an increase in farm size and intensification (2.3), fewer jobs per hectare are provided and thus results in less employment (8.5).
T8c	Outgoing	In case of an increase in farm size and intensification (2.3), fewer jobs per hectare are provided and thus results in less employment of youth specifically (8.6).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S8c, T8a and S8f were discussed. Regarding interaction S8c, INT7 notes that overall Kenya is concerned with ensuring sustainable practices at the policy level, but perhaps in the field somewhat unsustainable practices are in place. Increased knowledge of sustainable practices, regarding fertilizer use and feeding practices, might result in more sustainable practices at the field level. Additionally, INT7 notes, that by investing in innovation and training, particularly youth might become more interested to join agriculture and achieve increased productivity.

The trade-off and synergy between intensification practices to increase productivity (T8a & S8f), are recognised by INT2 and INT7. INT2 notes that the decoupling of agriculture, and especially livestock as an economic activity and trying to treat all the environmental issues as externalities is a challenge. He notes that the low emission development agenda is working against that, and is trying to address this trade-off and move towards utilising this synergy. INT7 elaborates on the challenges regarding the increasing number of livestock of pastoralists on wildlife and land degradation. She notes that increasing the number of livestock is a risk management strategy for the pastoralist. According to INT7, these practices could be addressed by addressing other factors, such as reducing the restriction of movement and other policies by the government to support pastoralism. Regarding this context, conservancy manager INT3 notes that their method for increased productivity in agriculture is centred around utilising the land more efficiently in a way that both the livestock and the land improve, and over time, improved land means improved livestock. By doing so, INT2 is not creating a trade-off between targets 2.3 and 8.4 but utilising the synergy between the two targets.

Interactions SDG2: 'Zero Hunger' and SDG9: 'Industry, Innovation and Infrastructure'

SDG9 is concerned with building resilient infrastructure, promoting sustainable industrialization and fostering innovation and consists of five targets which are described in Table 21.

Table 21: SDG9 and targets

SDG9	Build resilient infrastructure, promote sustainable industrialization and foster innovation
9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
9.2	Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries
9.3	Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets
9.4	By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
9.5	Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending

Source: United Nations (2015)

Interactions from literature

By analysing the selected 10 articles, four synergies were identified between the targets of SDG9 and SDG2. The interactions between SDG9 and SDG2 are illustrated in Figure 13. All four synergies were incoming SDG2. The identified interactions for each target are listed in Table 22. A more elaborate description can be found in Appendix 4.

Figure 13: Interactions between SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' & SDG9 'build resilient infrastructure, promote sustainable industrialization and foster innovation' (own representation).

Table 22: Description of identified interactions between SDG2 and SDG9

#*	Direction**	Description
S9a	Incoming	improving roads (9.1) from farmers to nearby towns increases market access, nudges farmers to participate in the milk market and results in the improved income for smallholder farmers (2.3).
S9b	Incoming	Access to markets (9.1) determines the availability of inputs required for climate change adoption and thus the ability of farmers to implement resilient and sustainable agricultural practices (2.4).
S9c	Incoming	In Kenya, improved infrastructure in the form of access to finance, markets and innovations (9.3), resulted in higher crop productivity and income (2.3).
S9d	Incoming	Capacity building and increasing access to finance (9.3) might overcome the current constraints (weak links between farmers and formal financing institutions and limited access to finance) to increase the adaptation of resilient and sustainable agricultural practices (2.4).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S9a, S9b and S9d were discussed. The three discussed interactions were widely recognised. Interactions S9a and S9b by INT2, INT3, INT4, INT6 and INT7. INT3 does note that realising infrastructure does have negative effects on conservation objectives.

Regarding interactions S9d, INT2 notes that he hasn't seen financial services from the formal sector for the smallholder sector as smallholders don't have access to banks for loans. He mentions that most loans go through informal services and how the financial resources of these smallholders are largely coming from remittances or loans from family members. Although, INT2, INT3, INT4, INT6 and INT7 do confirm that increasing the financial resources enable farmers to implement more sustainable agricultural practices as inputs can be bought and access to technologies is improved. INT6 describes how a project, Kenya Livestock Insurance program, utilises this synergy and provides financial resources to pastoral communities specifically. The project team noticed a direct correlation with the implementation of resilient agricultural practices.

INT7 describes a synergy between increased access to financial services and increased income for smallholder farmers. This synergy was not discussed in the interviews but is identified in the structured literature review and labelled as interaction S9c. INT7 further explains how a project team of CGIAR, the sustainable finance team, is concerned with increasing access to financial services, to increase the income of smallholder farmers.

Interactions SDG2: 'Zero Hunger' and SDG10: 'Reduced Inequalities'

SDG10 is concerned with reducing inequalities and consists of seven targets which are described in Table 23.

SDG10: Reduce inequality within and among countries	
10.1	By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average
10.2	By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status
10.3	Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard
10.4	Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality
10.5	Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulation
10.6	Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions
10.7	Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies

Source: United Nations (2015)

Interactions from literature

By analysing the identified 9 articles, three synergies were identified. All synergies are moving from SDG10 incoming SDG2, target 2.3 specifically. The interactions between SDG10 and SDG2 are illustrated in Figure 14. The identified interactions for each target are listed in Table 24. A more elaborate description can be found in Appendix 4.
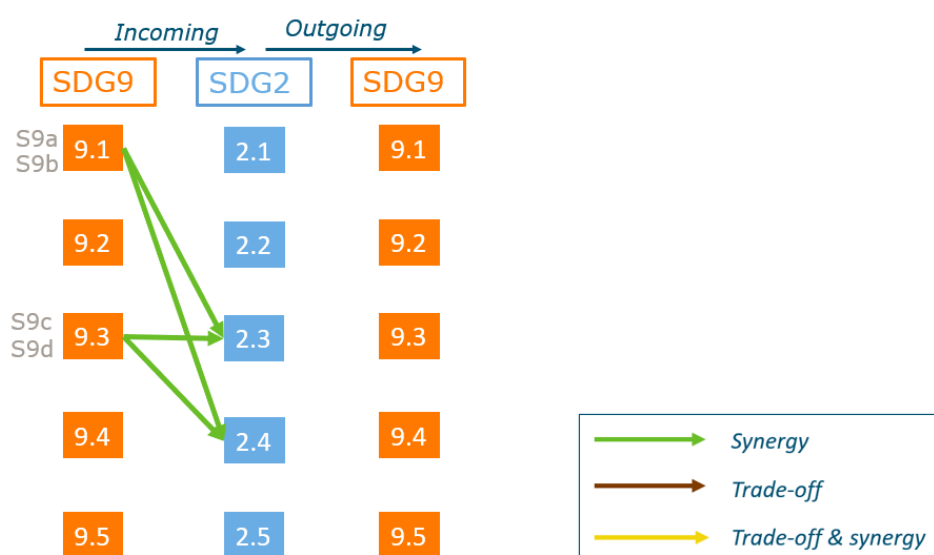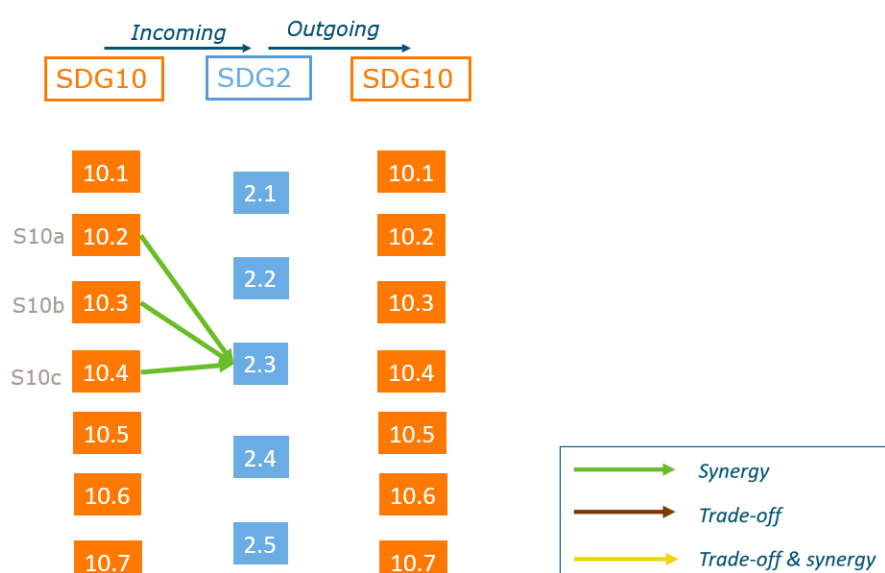

Figure 14: Interactions between SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' & SDG10 'Reduce inequality within and among countries' (own representation).

Table 24: *Description of identified interactions between SDG2 and SDG10*

#*	Direction**	Description
S10a	Incoming	Empowering and promoting the inclusion of women (10.2) when joining membership in bargaining and processing producer organizations of women empowerment, increases their access to agricultural resources resulting in increases in income for female dairy farmers (2.3).
S10b	Incoming	In women's informal milk market practices, ensuring equal opportunities in dairy farming (10.3) will increase the income of female smallholder farmers (2.3).
S10c	Incoming	In women's informal milk market practices, ensuring equal wage (10.4) will increase the income of female smallholder farmers (2.3).

Insights from expert interviews

During the interviews, interactions S10a, S10b and S10c were discussed. Interaction S10a and S10b are recognised by INT3, INT4, INT6 and INT7. INT2 notes that he recognised the inverse of interaction S10a. When a technological change in intensification is not inclusive, it can lead to increases in labour burden for women, while marginalising them from benefit, which decreases their incentive and motivation to invest and intensification practices. This leaves women not interested in intensification practices as there is nothing in them for them. This description of INT2 implies a trade-off between target 2.3 outgoing to target 10.2.

Regarding interaction S10c, INT2 has not seen many wage and social protection policies in practice yet does agree with the synergetic effect of implementing of social protection on reducing gender inequalities. INT6 too confirms this synergy but sees it as a very indirect interaction. INT4 mentions how pursuing profitability in agriculture might reduce wages. Then, thinking of adopting wage and social protection policies to achieve greater equality and asking whether that will increase agricultural productivity, a conflict might emerge. When you have to pay higher wages to employees, it does not perse increase productivity, but will increase the income of people employed in agriculture.

INT6 elaborates on policy formation and that a necessary condition in the agricultural policy development process, is that all social groups are included and it should promote equal opportunities in terms of access, and control to production resources. INT7 describes the existence of thematic working groups regarding gender and inclusion of indigenous communities and social groups and how she feels involved actors perceive it as something they have to do, while they do not fully understand and acknowledge the importance of the project. Additionally, she feels that the involved actors underestimate the interconnectedness of SDG10 with other SDGs and that reducing inequalities has synergies with SDG2 and other SDGs.

Interactions SDG2: 'Zero Hunger' and SDG11: 'Sustainable cities and communities'

SDG11 is concerned with making cities and human settlements inclusive, safe, resilient and sustainable and consists of seven targets which are described in Table 25.

SDG11: Make cities and human settlements inclusive, safe, resilient and sustainable	
11.1	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
11.2	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage
11.5	By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
11.7	By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

Source: United Nations (2015)

Interactions from literature

By analysing the selected 9 articles, no interactions were identified between the targets of SDG11 and SDG2.

Insights from expert interviews

Most experts (INT2, INT3, INT4 and INT6) are not surprised no interaction was identified between SDG2 and SDG11. INT7 briefly mentions that she expects an interaction when thinking of urban livestock and zoonotic diseases, but no specific interaction was implied between SDG11 and SDG2.

Interactions SDG2: 'Zero Hunger' and SDG12: 'Responsible consumption and production'

SDG12 is concerned with ensuring sustainable consumption and production and consists of eight targets which are described in Table 26.

Table 26: SDG12 and targets

SDG12: Ensure sustainable consumption and production patterns	
12.1	Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries
12.2	By 2030, achieve the sustainable management and efficient use of natural resources

12.3	By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses
12.4	By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment
12.5	By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
12.6	Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
12.7	Promote public procurement practices that are sustainable, in accordance with national policies and priorities
12.8	By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

Source: United Nations (2015)

Interactions from literature

By analysing the 12 identified articles, six synergies and one trade-off were identified between the targets of SDG12 and SDG2. The interactions between SDG12 and SDG2 are illustrated in Figure 15. Four synergies are incoming SDG2 from SDG12. Two synergies and one trade-off are outgoing SDG2 towards SDG12. Target 12.2 & 2.1 and target 12.2 & 2.4 are interaction in both directions. The identified interactions for each target are listed in Table 27. A more elaborate description can be found in Appendix 4.

Figure 15: Interactions between SDG-2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' & SDG12 'Ensure sustainable consumption and production patterns' (own representation).

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Table 27: *Description of identified interactions between SDG2 and SDG12*

#*	Direction**	Description
S12a	Incoming	Efforts to deliver sustainable and efficient management the use of natural resources (12.2) enable the delivery of ensuring food security (2.1).
S12b	Incoming	The sustainable and efficient use of natural resources (12.2) enables agricultural productivity to double (2.3).
S12c	Incoming	More sustainable and efficient use of natural resources in the context of dairy farming (12.2) results in more sustainable and resilient agricultural practices (2.4).
S12d	Incoming	Feeding livestock with insects which live of waste streams (12.5) is successful and simultaneously contributes to the delivery of more sustainable and resilient agricultural practices (2.4).
T12a	Outgoing	In Kenya, demand for meat and milk is expected to increase (2.1) and the production of these products will put more pressure on natural resources to meet all demand (12.2).
S12e	Outgoing	Sustainable and resilient agricultural practices (2.4) include sustainable and efficient use of natural resources (12.2).
S12f	Outgoing	Ensuring more sustainable practices (2.4) specifically regarding milk handling and transportation, will result in fewer losses due to spillage (12.3).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S12a, S12c, S12e and T12a were discussed and broadly recognised by experts without any extensive elaboration. INT3 describes how in the conservancy an effort is made to be efficient with the resources of the land. An example provided is how animals are culled that are not productive and sold at their peak. She highlights the need for the production of meat and utilization of resources to be as efficient as possible, to keep up with the growing needs of the growing Kenyan population.

Interactions SDG2: 'Zero Hunger' and SDG13: 'Climate action'

SDG13 is concerned with taking urgent action to combat climate change and consists of three targets which are described in Table 28.

Table 28: *SDG13 and targets*

SDG13: Take urgent action to combat climate change and its impacts	
13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
13.2	Integrate climate change measures into national policies, strategies and planning
13.3	Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

Source: United Nations (2015)

Interactions from literature

By analysing the 14 identified articles, six synergies and one trade-off were identified between the targets of SDG13 and SDG2. The interactions between SDG13 and SDG2 are illustrated in Figure 16. Five synergies and one trade-off are incoming SDG2 from SDG13. One synergy is outgoing SDG2 towards SDG13. Target 13.1 & 2.4 are interacting both ways. The identified interactions for each target are listed in Table 29. A more elaborate description can be found in Appendix 4.
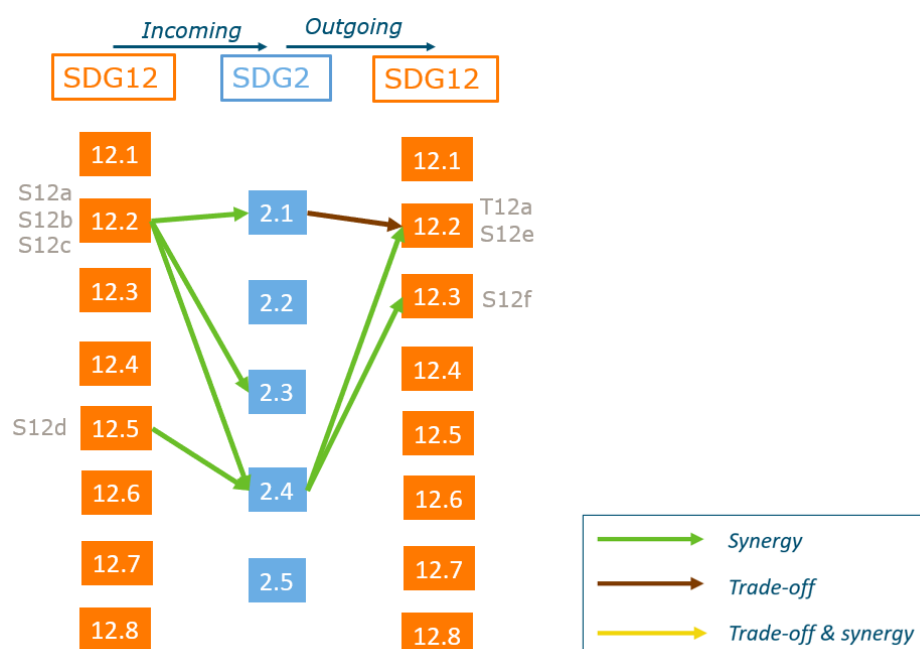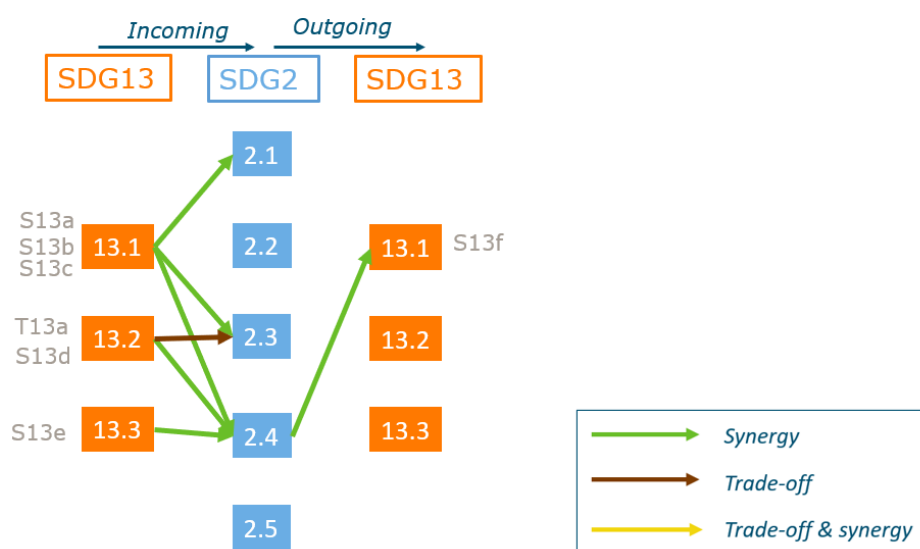

Figure 16: *Interactions between SDG13 'Take urgent action to combat climate change and its impacts' & SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (own representation).*

Table 29: *Description of identified interactions between SDG2 and SDG13*

#*	Direction**	Description
S13a	Incoming	Amongst pastoralists, livestock numbers are shown to decrease as a result of droughts with negative effects on farmer households and well-being and food security. Efforts to strengthen resilience and adaptive capacity to climate-related hazards (13.1) contribute to the delivery of ensuring food security (2.1) amongst pastoralists.
S13b	Incoming	For dairy farmers, becoming more resilient against climate change (13.1) by adopting other feed crops which are not much impacted by climate change effects results in increased productivity (2.3).
S13c	Incoming	Strengthening resilience and adaptive capacity to climate-related hazards and natural disasters (13.1) implies delivering sustainable and resilient agricultural practices (2.4).
T13a	Incoming	When investigating the effects of institutional constraints on the effectiveness of climate action amongst small-scale dairy farmers, it was found that in some cases practices to deliver climate action (13.2) undermine productivity and income (2.3).
S13d	Incoming	Implementing climate change measures (13.2) speeds up the process to deliver sustainable agriculture (2.4).
S13e	Incoming	Exposure of farmers to climate information increases the knowledge and awareness of climate change (13.3) and therefore results in an increase in the adoption of climate-smart and resilient agricultural practices (2.4).

S13f	Outgoing	Delivering sustainable and resilient agricultural practices (2.4) implies strengthening resilience and adaptive capacity to climate-related hazards and natural disasters (13.1).

* S = Synergy. T = trade-off
** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target

Insights from expert interviews

During the interviews, interactions S13a, S13b and S13e were discussed. INT1 noted how in terms of achieving long term development goals, the question of agriculture and food systems is very critical, and the role of ensuring sustainable & resilient agricultural practices in Kenyan's long term development vision. He describes how a lot of resources are invested in ensuring resilient agriculture through the KCASP program and the many interactions between development parties and the private sector which are putting a lot of effort in terms of supporting knowledge, development in terms of this respect. INT7 confirms the focus on building resilient agriculture in national policies and activities and describes that the dairy sector is seen as a place where Kenya has the potential to help meet its National Determined Contribution to lower greenhouse gas emissions.

Interaction S13a was recognised by all experts and S13b by INT4, INT5 and INT6. No other expert refuted this interaction. Additionally, INT2 perceives interaction S13a, between target 13.1 and 2.1 in a circular shape and therefore implies the existence of another synergy outgoing target 2.1 to target 13.1. He elaborates that resilience to hazards and extreme events are shown through the maintenance of food security in the face of stress and thus by ensuring food security, resilience is strengthened. INT2 noted that in her experience, food security is more tied to logistics and politics and being resilient to climate-related hazards is not sufficient in itself to achieve food security. INT7 recognised interaction S13b between target 13.1 and 2.3 and suggests the existence of another synergy outgoing target 2.3 to 13.1, as he expects that when income from agricultural production is increased, resilience can be strengthened. This implied synergy was not identified when conducting the structured literature review.

Regarding addressing interactions S13a and S13b, INT4 and INT6 expressed how the projects and policies they are engaged with, are making use of this synergy to deliver multiple SDGs simultaneously. The Climate Resilient Agribusiness for Tomorrow (CRAFT) project pushes climate action and technologies which enhance better energy or water use for farmers to increase productivity and income. Additionally, the experts mention how the existing Kenya Climate Smart Agriculture Strategies & the Livestock Climate Change Action Plan which is in its very early stages, support technologies, innovations and management practices to deliver sustainable development.

Interaction S13c, was partly recognised by experts. INT2 notes that in his experience education on climate change adaptation receives more attention. He perceives realising education on climate change mitigation for Kenyan dairy farmers as not very successful in ensuring sustainable and resilient agricultural practices as it is not actionable information. INT3 elaborates on how a project regarding cattle management

across conservancies utilises this synergy as it educates conservancy members on how specific livestock management practices aiming to achieve maximum quality, can improve ecosystems. INT5 described that when people are more aware of climate change and adaptation strategies, this could have co-benefits for achieving food security and doubling productivity. Therefore, he implies two other synergies between target 13.1, incoming targets 2.1 and 2.3. These implied interactions were not identified in the structured literature review.

INT3 expresses how she is careful when thinking of climate change impacts on the conservancy and in Kenya in general, as she experiences that often the changing climate is blamed for the changing landscape, while in her perception it is often mismanagement of land.

Interactions SDG2: 'Zero Hunger' and SDG14: 'Life Below Water'

SDG14 is concerned with conserving and the sustainable use of oceans, seas and marine resources and consists of seven targets which are described in Table 30.

Table 30: SDG14 and targets

SDG14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development	
14.1	By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
14.2	By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
14.3	Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels
14.4	By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics
14.5	By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information
14.6	By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation
14.7	By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism

Source: United Nations (2015)

By adhering to the selection criteria of the structured literature review, no articles were identified. Therefore, no interaction was identified between the targets of SDG14 and SDG2 in this structured literature review.

Insights from expert interviews

When discussing potential interactions between SDG14 and SDG2, INT2 & INT7 mentioned the case of keeping manure produced during dairy production out of the streams in order to protect lakes and freshwater. INT6 added that especially intensive dairy production systems include affluence and nutrient loss which affects biodiversity. This interaction is not direct as these production systems are very far away from some of these permanent water sources. Additionally, INT3 expects interactions between the two SDGs in the context of Mombasa, a coastal city, but not in the context of dairy production. INT4 expressed that SDG14 contributes to SDG2 by the provision of fish and protein to diets, but this is outside the scope of this study as the context is limited to cow husbandry and milk production and does not include fish production or consumption. Thus, although experts see linkages between the two SDGs, no direct interaction was implied in the context of dairy production in Kenya.

Interactions SDG2: 'Zero Hunger' and SDG15: 'Life on Land'

SDG15 is concerned with protecting, restoring and promoting the sustainable use of terrestrial ecosystems, halting the loss of biodiversity and combating desertification and land degradation. SDG15 consists of nine targets which are described in Table 31.

Table 31: SDG15 and targets

SDG15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	
15.1	By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements
15.2	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally
15.3	By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world
15.4	By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development
15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species
15.6	Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed

15.7	Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products
15.8	By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species
15.9	By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

Source: United Nations (2015)

Interactions from literature

By analysing the 23 identified articles, twelve synergies and four trade-offs were identified between the targets of SDG15 and SDG2. The interactions between SDG15 and SDG2 are illustrated in Figure 17. Five synergies were incoming SDG2 from SDG15. Seven synergies and four trade-offs outgoing SDG2 towards SDG15. The targets 15.1 & 2.1, 15.3 & 2.3 and 15.2 & 2.4 are interacting both ways. The identified interactions for each target are listed in Table 32. A more elaborate description can be found in Appendix 4.
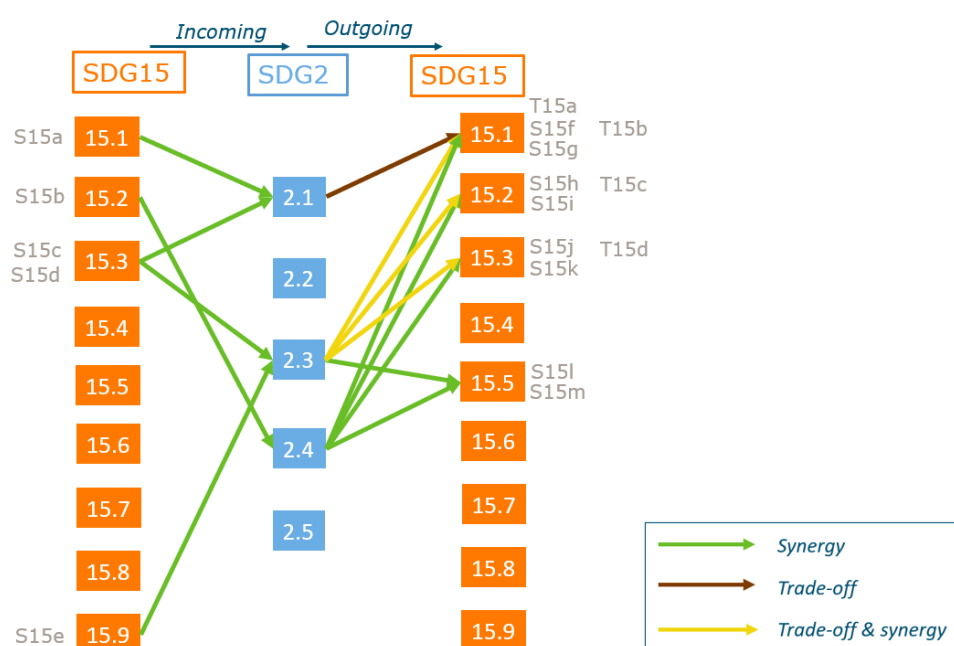
Figure 17: Interactions between SDG15 'Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss' & SDG2 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' (own representation).

Table 32: Description of identified interactions between SDG2 and SDG15

#*	Direction**	Description
S15a	Incoming	Conserving ecosystems (15.1) enables sufficient production to provide food for all (2.1).

S15b	Incoming	Ensuring the restoration and conservation of forests (15.2) enables the implementation of sustainable livestock production systems (2.4).
S15c	Incoming	Improved quality of land and soil due to restoration (15.3), results in improved food security of the farmer households (2.1).
S15d	Incoming	Efforts to combat degradation (15.3) help to increase productivity (2.3) because in that case there is more land for grazing available and fewer conflicts between livestock and wildlife.
S15e	Incoming	Integrating ecosystem values into national and local planning, development processes and poverty reduction (15.9) contributes to increasing the income of smallholder farmers (2.3).
T15a	Outgoing	Ensuring food security (2.1) by providing dairy product to everyone, puts more pressure on land and forests and impede conservation efforts (15.1).
S15f	Outgoing	Increasing agricultural productivity (2.3) contributes to the conservation of ecosystems (15.1).
T15b	Outgoing	Doubling agricultural productivity (2.3) by means of dairy intensification hampers the delivery of conservation of the ecosystem (15.1) as intensification pollutes water and air.
S15g	Outgoing	Implementing sustainable agricultural practices (2.4) enabled Kenyan dairy farmers to contribute to the conservation of freshwater ecosystems and their services (15.1)
S15h	Outgoing	Currently deforestation occurs due to realizing agricultural expansion. By increasing agricultural productivity (2.3), less expansion is needed and therefore contributes to the delivery of combating deforestation (15.2).
T15c	Outgoing	Doubling agricultural productivity by means of dairy intensification (2.3) hampers the delivery of halting deforestation (15.2).
S15i	Outgoing	Implementing sustainable agricultural practices (2.4) enables Kenyan dairy farmers to contribute to the conservation of forests (15.2)
S15j	Outgoing	Increasing agricultural productivity (2.3) contributes to the delivery of combating land degradation (15.3)
T15d	Outgoing	Doubling agricultural productivity (2.3) by means of dairy intensification hampers the delivery of combating land degradation (15.3) as intensification contributes to land degradation and emissions.
S15k	Outgoing	Implementing sustainable agricultural practices (2.4) enabled Kenyan dairy farmers to contribute to the conservation of land to restore land and improve the quality of land and soil (15.3)
S15l	Outgoing	Increasing agricultural productivity (2.3) contributes to the delivery of combating the degradation of natural habitats (15.5).
S15m	Outgoing	Implementing sustainable agricultural practices (2.4) enabled Kenyan dairy farmers to contribute to the conservation of biodiversity and natural habitats (15.5).

S = Synergy. T = trade-off
*** Incoming = Incoming SDG2 from other target. Outgoing = outgoing SDG2 to other target*

Insights from expert interviews

During the interviews, interactions S15c, S15j, T15d and S15l were discussed. Regarding S15c, all experts recognised this interaction. INT6 emphasised the importance of forests for grazing for smallholder farmers during the dry months. INT2 highlighted that efforts to intensively start production, producing fodder and opening up fresh land for hay fields, might be perceived as good from the farm gate but bad if you take a

landscape approach, and that gains in the dairy sector hardly compensate for land conversion and the resulted carbon release. INT4 reinforces this and mentions the negative effects in terms of deforestation resulting from farmers expanding facilitated by increased productivity. Both INT2 and INT4 describe a trade-off between target 2.3 and 15.2, which was not presented to them in the interview but was identified when conducting the structured literature review. INT4 also acknowledges that if the sustainable practices are implemented to increase productivity it could have co-benefits to combatting deforestation. INT5 mentioned how the projects that he is engaged with utilises this synergy, by introducing agroforestry practices.

Interaction S15l, was recognised by four experts (INT1, INT4, INT5 and INT6). The synergy and trade-off between target 2.3 and 15.3 are recognised by six experts (INT1, INT3, INT4, INT5, INT6 and INT7). INT1 noted that doubling agricultural productivity speaks to the intensity of land use. He elaborated on these interactions in the context of pastoralists' livestock systems and the balancing act of increasing the numbers of livestock in a given range area, managing that the land will not be degraded and the importance of how resources are used which determine if a synergy or trade-off is in place. Additionally, INT1 highlighted the consequence of degradation of lands on water availability for wildlife. If the water points, which wildlife uses as a source for drinking water, become degraded, the wildlife will search for water in other places and might invade pastoralist settlements and other farms. INT6 experienced the trade-off between the two targets, as commercialisation is driving desertification and explains how policies are in place to address the problem of desertification and land degradation, specifically for pastoralists' livestock systems.

4.2 Overview of identified interactions

By conducting the structured literature review, 85 interactions between the targets of SDG2 and other SDGs were identified. This subchapter elaborates on six findings that can be drawn from the results of this study. Appendix V contains tables presenting the amount and nature of interactions per target of SDG2 and per SDG.

The findings on the interactions are:

- *Finding 1: There exist more synergies than trade-offs between the targets of SDG2 and other SDGs.*
- *Finding 2: There exist more interactions incoming SDG2, compared to interactions outgoing SDG2.*
- *Finding 3: More interactions exists regarding target 2.3 and 2.4 compared to targets 2.1, 2.2 and 2.5.*
- *Finding 4: Most frequent interactions incoming SDG2 depart from SDG4, SDG8, SDG13 and SDG15.*
- *Finding 5: Most frequent interactions outgoing SDG2 are directed to SDG15, SDG3 and SDG8.*
- *Finding 6: No interactions exist between SDG2 and SDG11 & SDG14.*

The following paragraphs will elaborate on each finding.

Finding 1: There exist more synergies than trade-offs between the targets of SDG2 and other SDGs.

In this study, 69 synergies and 16 trade-offs were identified between the targets of SDG2 and other SDGs in the context of dairy production in Kenya. Figure 18 illustrates all identified synergies and Figure 19 illustrates all trade-offs.

Synergies
For 69 combinations of targets, it implies that efforts to achieve one target simultaneously contribute to the delivery of another target, a synergetic interaction. When looking at Figure 18 we see that most synergies exist regarding target 2.3 (28 synergies) and target 2.4 (24 synergies).

Looking at synergies regarding SDG2 in general, most synergies are incoming SDG2 (45 outgoing synergies) see Figure 18. This implies that efforts to achieve targets of other SDGs, simultaneously contribute to the delivery of SDG2. From Figure 18 we see most synergies incoming SDG2 are resulting from efforts to deliver SDG4, SDG8, SDG9, SDG13 and SDG15. Efforts to increase the level of education (SDG4), entrepreneurial, technical and managerial skills (SDG8), access to markets (SDG9), increasing awareness regarding climate change resilience (SDG13) and conserving natural resources and ecosystems simultaneously contribute to the delivery of one or more targets of SDG2.

Synergies outgoing SDG2 (24 synergies) are mainly directed toward SDG3 and SDG15. Efforts to deliver food security, increase agricultural productivity and deliver sustainable food production systems

(SDG2), simultaneously contributed to the delivery of improving health and well-being (SDG3), and conserving ecosystems and natural resources.

Trade-offs

For 16 combinations of targets, trade-offs exist. This means that efforts to achieve one target impede the delivery of another target. Figure 19 illustrates that the majority of trade-offs are outgoing SDG2, and target 2.3 specifically. This implies that efforts to deliver on SDG2 impede the delivery of 13 other SDGs targets. Looking at the target level, efforts to deliver target 2.3, impede the delivery of 10 targets of other SDGs.

Of the 16 trade-offs between targets of SDG2 and other SDGs, 13 trade-offs are outgoing SDG2, and 3 trade-offs are incoming SDG2. Trade-offs outgoing SDG2 are mostly directed towards SDG15, SDG6 and SDG8. Efforts to achieve food security and increase agricultural productivity impede combating land degradation, conservation of ecosystems and natural habitats (SDG15), delivering access to water for all and addressing water scarcity (SDG6) and full employment (SDG8).

Incoming trade-offs directed to SDG2 derived from SDG1, SDG4 and SDG13. Particular efforts to reduce the number of people living in poverty (SDG1) impede ending malnutrition. Efforts to increase levels of education completed (SDG4) and deliver climate action (SDG13) hamper the process of delivering increased productivity and income from agricultural practices (SDG2).
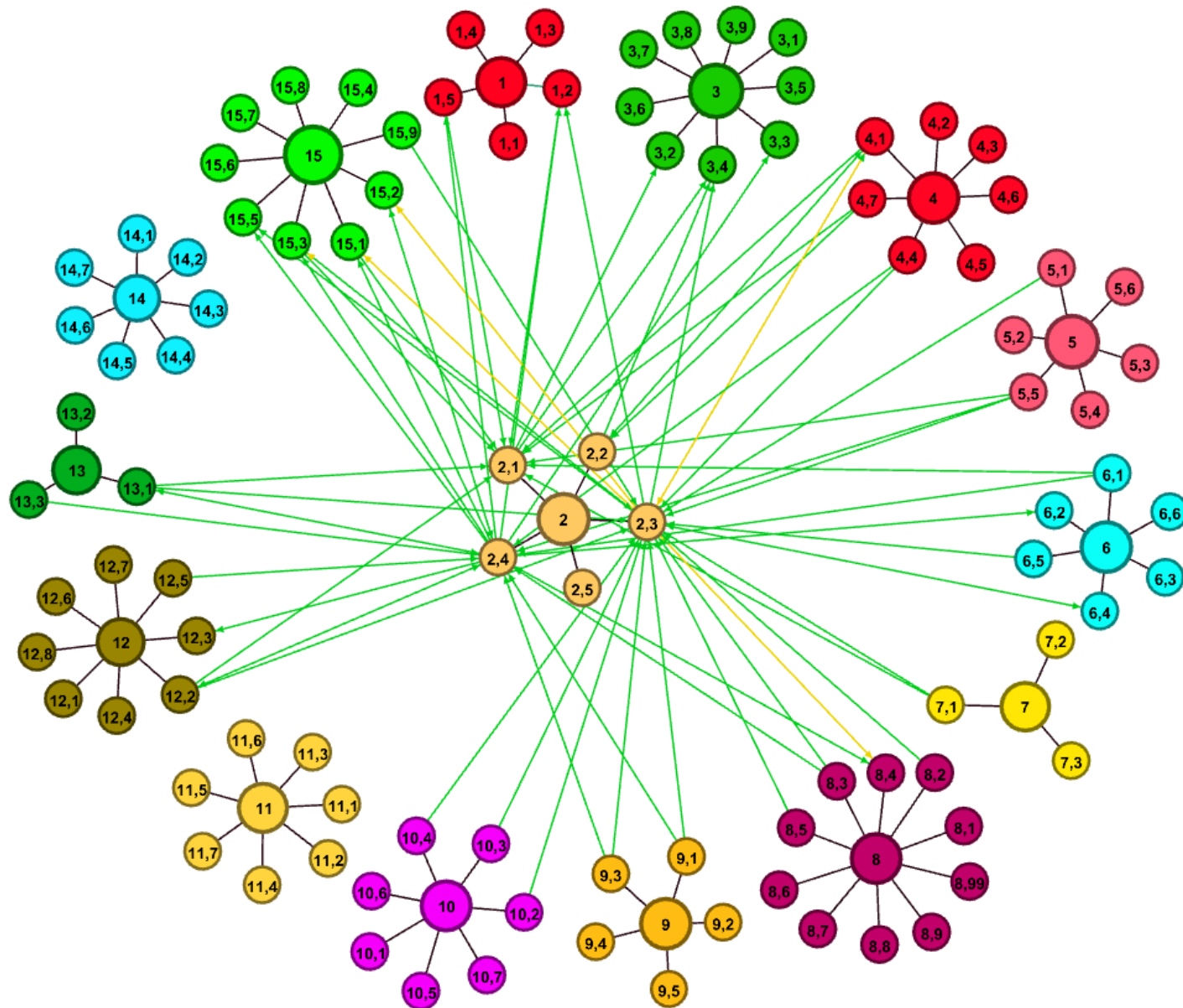
Figure 18: *Illustration of all synergies between targets of SDG2 and other SDGs (own representation).*
Green arrows represents a synergetic relationship. Yellow arrows indicate both a synergy and trade-off.
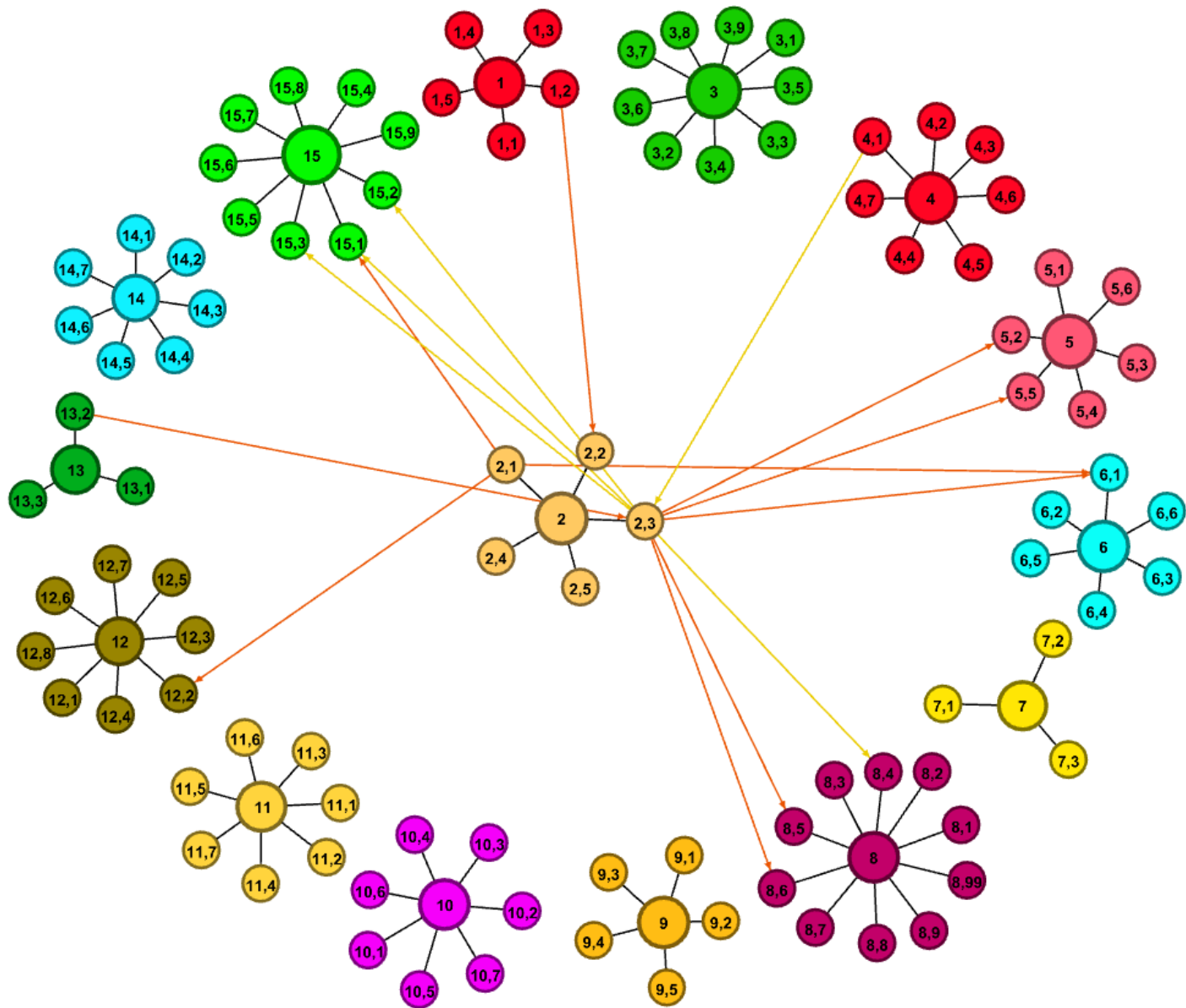
Figure 19: Illustration of all trade-off between targets of SDG2 and other SDGs (own representation). Red arrows represents a trade-off. Yellow arrows indicate both a synergy and trade-off.

Figure 20 presents all interactions outgoing SDG2. Thus, Figure 20 presents all incidences where efforts to achieve other SDGs, simultaneously impede (trade-off) or contribute (synergy) to the delivery of SDG2. Figure 21 presents all identified interactions incoming SDG2. Thus, Figure 21 presents all incidences where efforts to achieve SDG2 impede (trade-off) or contribute (synergy) to the delivery of the other SDGs. The two figures illustrate that there exist more interactions incoming SDG2 (48 interactions) than interactions outgoing SDG2 (37 interactions). Subsequently, out of the 48 incoming interactions, only 3 are trade-offs while out of 37 outgoing interactions, 13 interactions are trade-offs. Therefore, efforts to achieve targets of SDG2 are more likely to impede the delivery of other SDGs compared to efforts to achieve targets of other SDGs on the delivery of SDG2.

Figure 20: *Illustration of all interaction outgoing SDG2 directed to targets of other SDGs (own representation).*
Green arrows represents a synergetic relationship. Red arrows represent a trade-off. Yellow arrows indicate both a synergy and trade-off.
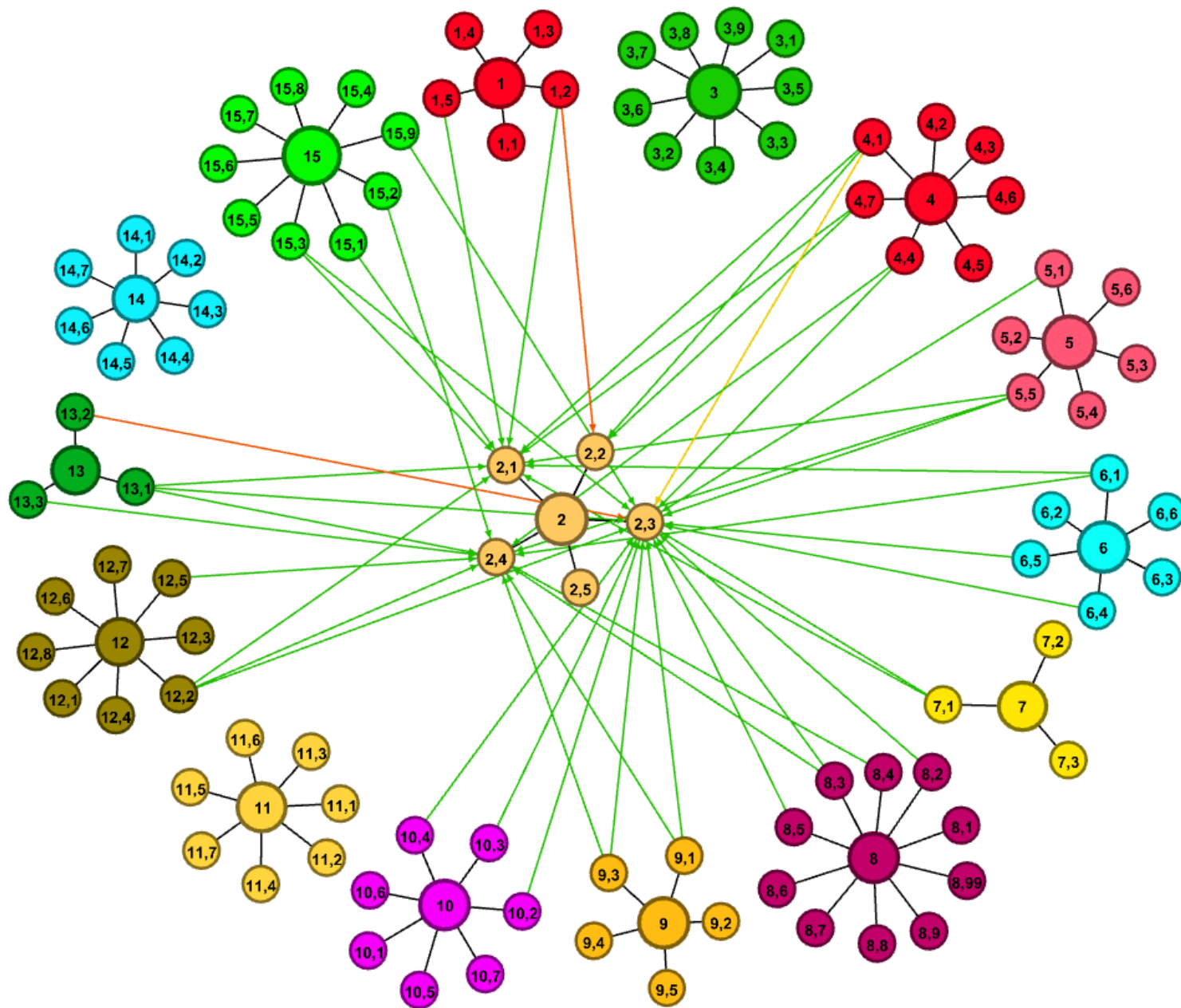
Figure 21: *Illustration of all interaction incoming SDG2 from of other SDGs (own representation).*
Green arrows represents a synergetic relationship. Red arrows represent a trade-off. Yellow arrows indicate both a synergy and trade-off.
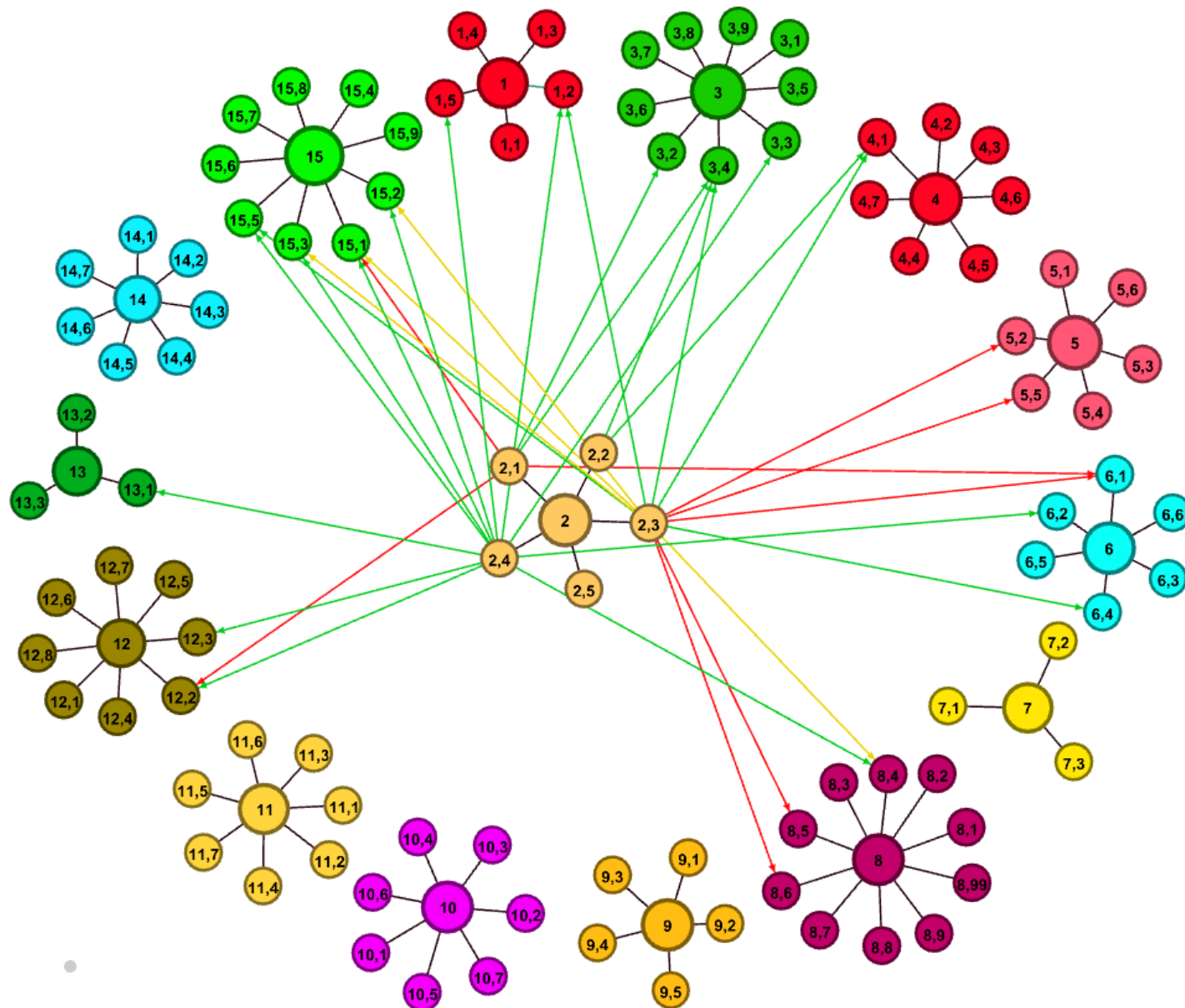
Figure 22 presents four network analyses illustrating the interactions between the targets of SDG2 with targets of other SDGs. The figure illustrates that targets 2.3 and 2.4 are interacting more frequently with targets of other SDGs (target 2.3 40 interactions, target 2.4 24 interactions), compared to targets 2.1 (16 interactions), target 2.2 (5 interactions) and target 2.5 (0 interactions).

Target 2.1: ending hunger and ensuring access to safe, nutritious and sufficient food for everyone all year round, was found to have 16 interactions with targets of other SDGs, mainly synergies (13 synergies) incoming SDG2 (11 incoming synergies). Efforts to ensure ending poverty (SDG1), quality education (SDG4), gender equality (SDG5), clean water and sanitation (SDG6), affordable and clean energy (SDG7), responsible consumption and production (SDG12), climate action (SDG13) and conserving and protecting life on land (SDG15) simultaneously contribute to the delivery of ending hunger and achieving food security. Yet, trade-offs are present outgoing target 2.1 toward SDG6, SDG12 and SDG15. While aiming to achieve food security, one should keep in mind that this might impede achieving ensuring access to safe drinking water (SDG6), achieving sustainable management and efficient use of natural resources (SDG12) and conservation of natural resources (SDG15) once the production of food to feed all, is not taking these other development objectives into account.

Target 2.2: ending all forms of malnutrition, has 5 interactions with targets of other SDGs, mainly synergies (4 synergies) and regarding SDG4. Efforts to increase the level of education completed (SDG4) contributed to eradicating malnutrition. Moreover, ending malnutrition improves cognitive function and school performance (SDG4) and health and well-being (SDG3) of children. The delivery of ending malnutrition is hampered in case efforts to end poverty (SDG1) result in women dedicating their time to creating income instead of feeding their children with breastmilk.

Target 2.3: increasing agricultural productivity and income of all small-scale food producers, has 39 interactions with targets of other SDGs, of which 27 synergies and 12 trade-offs. Most synergies (19) are incoming SDG2, while most trade-offs are outgoing SDG2 (10). Progress is made on the delivery of target 2.3 when efforts to deliver SDG4-SDG13 and SDG15 are in place. Yet, efforts to achieve increasing agricultural productivity hampers the delivery of ensuring women empowerment (SDG5), access to safe drinking water (SDG6), full employment (SDG8) and protection and conservation of ecosystems and combatting land degradation (SDG15) in case these efforts to increase productivity are unsustainable.

Target 2.4: ensure sustainable food production systems and implement resilient agricultural practices, has 25 interactions with targets of other SDGs, of which all are synergies. No trade-offs were identified. 13 synergies are incoming target 2.4 and 12 synergies are outgoing target 2.4. Most synergies arise between target 2.4 and ensuring full and productive employment (SDG8), responsible production and consumption (SDG12), implementing climate change measures and ensuring climate resilience (SDG13) and protection and conservation of ecosystems and combatting land degradation (SDG15).
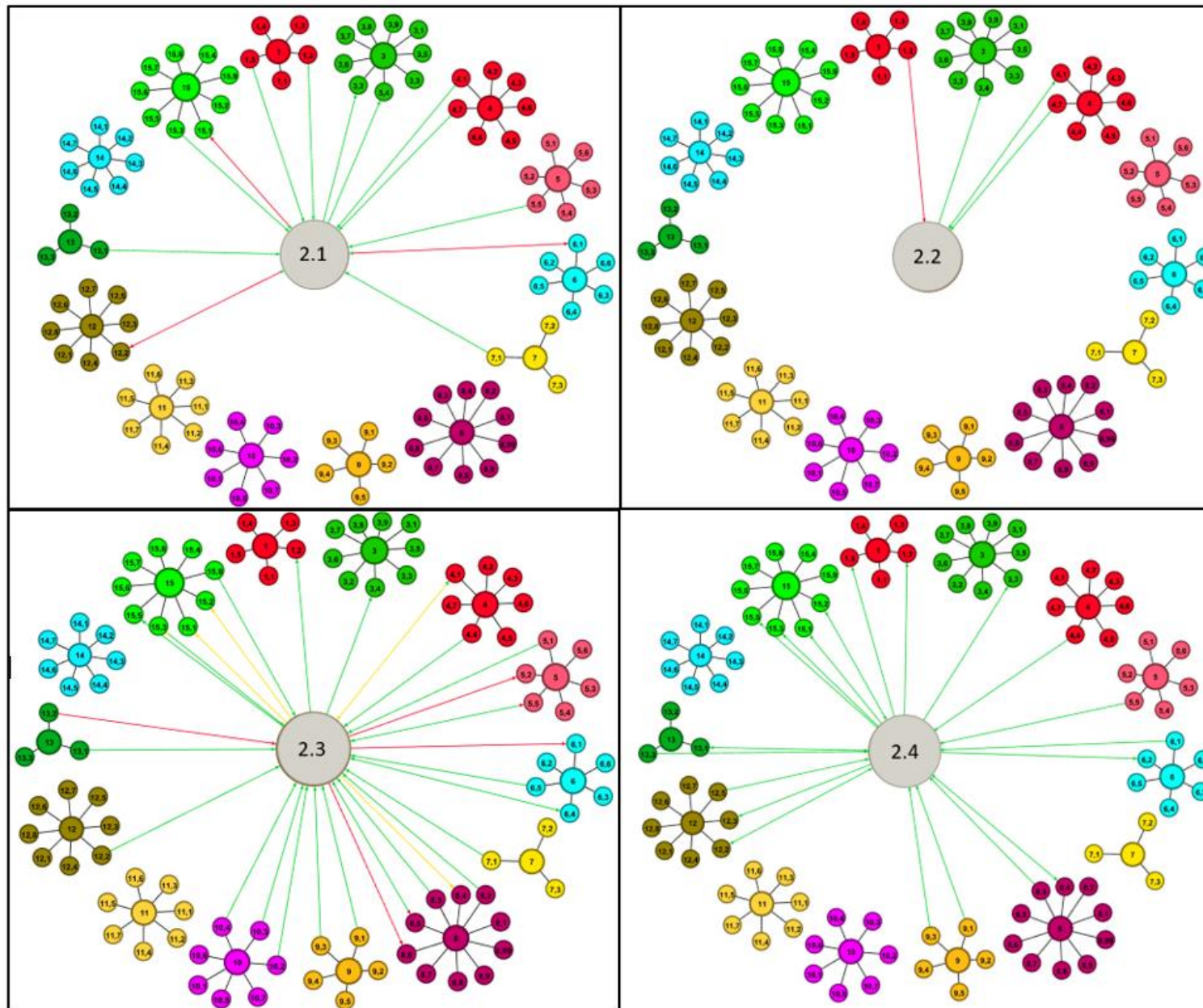
Figure 22: Illustration of interactions between four different targets of SDG2 and other SDGs (own representation). Target 2.1: 'Ending hunger and ensuring access to safe, nutritious and sufficient food for everyone all year round'. Target 2.2: 'Ending all forms of malnutrition' Target 2.3: 'Increasing agricultural productivity and income of all small-scale food producers'. Target 2.4: 'Ensure sustainable food production systems and implement resilient agricultural practices'.

Target 2.5 is excluded as no interactions with targets of other SDGs were identified.

Finding 4: Most frequent interactions incoming SDG2 depart from SDG4, SDG8, SDG13 and SDG15.

Figure 23 presents all identified interactions at goal level. Based on the conducted structured literature review, interactions incoming SDG2 are departing mostly from SDG4 (8 interactions), SDG8 (5 interactions), SGD13 (6 interactions) and SDG15 (5 interactions). The majority of these interactions are synergies. Efforts to achieve SDG3, SDG11 and SDG14 do not affect the delivery of SDG2, as no interactions were identified. Efforts to achieve SDG5, SDG6, SDG7, SDG8, SDG9, SDG10, SDG12 and SDG15 contribute to the delivery of SDG2. Efforts to achieve SDG1, SDG4 and SDG13 both contribute to and impede the delivery of SDG2.

Finding 5: Most frequent interactions outgoing SDG2 are directed to SDG15, SDG3 and SDG8.

Figure 23 illustrates that interactions outgoing SDG2 are mostly directed towards SDG3 (5 interactions), SDG8 (5 interactions) and SDG15 (12 interactions). The majority of these interactions are synergies. 13 trade-offs exist and are directed towards SDG6, SDG8, SDG12 and SDG15. No interactions outgoing SDG2 directed to SDG7, SDG9, SDG10, SDG11 and SDG14 were identified.

Finding 6: No interactions exists between SDG2 and SDG11 & SDG14.

Based on the conducted structured literature review, no interactions were identified between SDG2 and SDG11 and SDG14, Figure 23.
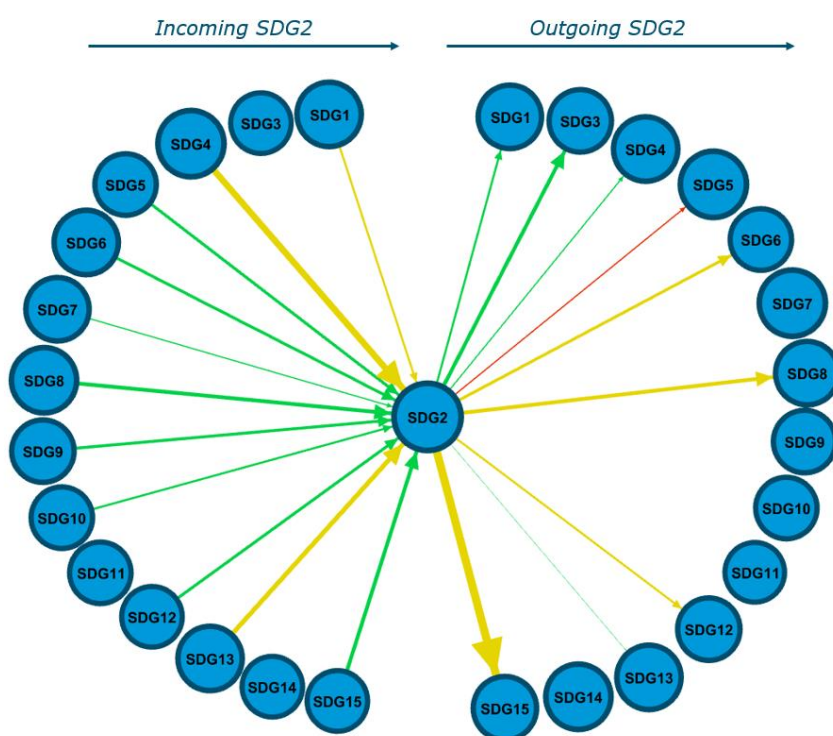
Figure 23: Illustration of interactions between the SDG2 and other SDG2 at the goal level (own representation). The thickness of the arrow represents the amount of synergies and or trade-offs present between the SDGs' targets. Green arrows represents a synergetic relationship. Red arrows represent a trade-off. Yellow arrows indicate both a synergy and trade-off.

4.3 Ranking of SDG interactions by experts

In order to get an understanding of how experts perceive SDG interactions and how they would prioritize these interactions, experts were asked to rank the five SDGs interacting with SDG2 on which are most important to address in the context of dairy production in Kenya. Prior to this, experts were asked to name the SDGs they are working on/contributing to in their professional activities. This question was asked under the assumption that which SDGs experts are currently working on, influences the ranking of the SDG interactions.

Figure 24 illustrates the number of experts concerned with/working on each SDG (green bar) and how much the interactions of this SDG with SDG2 are prioritised compared to interactions with other SDGs (orange bar). Figure 24 shows SDG13, SDG5 and SDG1 being ranked as most important to address their interactions with SDG2. Subsequently, these three SDGs are also the three SDGs which experts are most engaged with. No experts named the interactions between SDG2 with SDG4, SDG11 and SDG14 in their top 5 rankings. For SDG11 and SDG14, this is not surprising as no interactions were identified. Yet, between SDG2 and SDG4 9 synergies and 1 trade-off were identified.
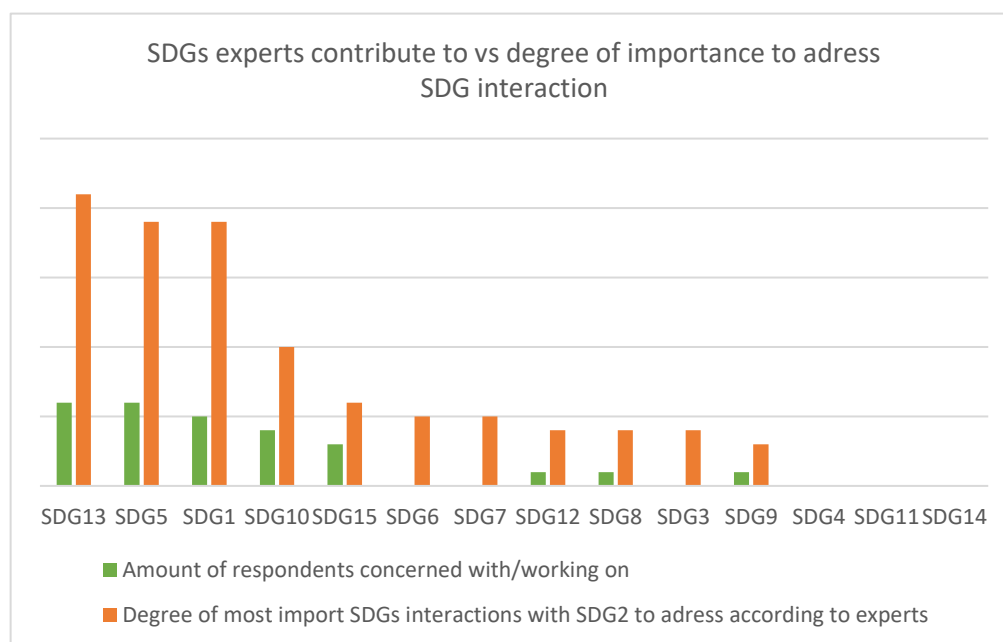
Figure 24: Graph illustrating to what SDGs experts contribute to vs the degree of importance to address SDG interactions according to experts

4.4 What is needed to better address SDG interactions according to experts

After discussing all interactions between SDG2 and the other SDGs, experts were asked to answer the question of what is needed to better address trade-offs and utilise synergies in the context of dairy production in Kenya. By presenting the results of what according to experts is needed to better address trade-offs and utilise synergies, RQ3 will be answered.

I – Policy integration & implementation

Five out of seven experts mention the need to improve policy integration of various aspects. Firstly, integration to align sectoral policies. INT4 mentions the need to better harmonize policies surrounding agriculture and climate issues in order to prevent policies that contradict each other. INT6 reinforces this statement and adds that there is a need to look at how different policies interact with each other. Furthermore, according to INT6, all policy formulation should be a more multi-disciplinary process.

Secondly, integration to align policy levels. INT4 mentions how in the case of addressing gender inequality, policies are in place but the issue arises on how these policies are cascaded into the sub-national government. Therefore, he stresses the need to make sure policies across levels are aligned.

Thirdly, integration to align science and policies. According to INT7 better science-policy engagement and alignment are needed in order for the science community to provide relevant knowledge to stakeholders. This ties into the request of INT6, a government official, who expresses the need for more research on the working of current policies.

Furthermore, experts express the need to improve policy implementation in two aspects. Firstly, experts express the need for integrated policies serving diverse contexts. INT1 describes how in Kenya livestock systems are set up in very different ways and thus need very different support. For this reason, INT1 expresses the need for well-informed support and coordination in order to customize policies so they serve different categories of livestock systems and people.

Secondly, the importance of enforcement and ownership of policies was stressed by INT5. INT5 mentions he is pleased with the existing policy in Kenya, yet points out the lack of enforcement of policies and how policies correspond as a reason why trade-offs between interactions exist and why synergies are not utilised.

II – Capacity building

Four experts expressed the need for capacity building by bringing the ideas and technologies developed by international or national actors down to the people and small-holder farmers. INT1 expressed that there exists a lot of interesting technologies, ideas and policies at the national level but the challenge lies in bringing this down to the people. INT2 agrees with the need to bring ideas to practical spaces for capacity building. He proposes incentives as a way to achieve this. INT1 links the need for more alignment between

actors to capacity building. Yet, he states that the challenge of this solution is that it is an expensive process and thus building a strong financial system is critical. INT4 is specifically focused on improving the access to technologies for small scale farmers. Technologies which are not only concerned with climate change adaptation but also regarding processing and storage and energy efficiency. Regarding SDG interactions, INT4 and INT5 mention the need for training for farmers in order to better address trade-offs and utilise synergies between SDGs. INT5 elaborates on the interaction between SDG2 and SDG13 by stating that when farmers have increased awareness of how their day-to-day farming practices contribute to climate change, the ways they can reduce this, why this is important and how they can benefit from sustainable agricultural practices, they are more likely to change their practices. INT3 specifically brings forth responsible livestock management and regenerative grazing training.

III – Increased awareness of SDG interactions

INT6 expressed the need to increase awareness of SDG interactions among actors. When increased awareness of SDG interactions is achieved, he expects it will be less likely that projects unintendedly result in a trade-off for an SDG while contributing to another. INT2 specifically expresses the need for increased attention to social equity and gender issues by the international and national community, as it is not addressed adequately according to him.

IV- Increased actor interaction & alignment

INT7 emphasises the need for increased interactions between stakeholders and to better understand what role actors and in specific actors in the private sector play. By doing so, a better understanding can be created of how trade-offs and synergies could be better addressed by actors and value chains. INT1 emphasises building partnerships as a tool to improve actor alignment which is believed to contribute to governing SDG interactions.

Chapter 5: Discussion

This chapter reflects on the results of the study. Firstly, it discusses the interpretations of the identified interactions, how these are perceived by experts and what is needed according to experts to better address these interactions. Secondly, it will discuss the limitations of the study. Thirdly, it will discuss the implications of the results of this study and why these results matter.

5.1 Interpretations of results

By analysing 178 relevant literature results, this study has identified 85 interactions between targets of SDG2 and targets of SDG1, SDG3-SDG15. This subchapter starts with a discussion of the interpretations of the identified SDG interactions and loops of interactions. Secondly, it discusses ways to weigh SDG interactions in order to be able to understand which interactions need to be prioritised in addressing these interactions. Thirdly, the contextual aspect of SDG interactions is discussed. Lastly, the interpretations of the results regarding ways to better address SDG interactions are discussed.

5.1.1 interpretations of identified interactions

The 85 interactions identified in this study for the chosen context, illustrate the interconnectedness of the SDGs. In the results chapter, the six findings were presented. Finding 1: '*There exist more synergies than trade-offs between the targets of SDG2 and other SDGs',* creates a promising outlook for policymakers and development actors as there exist more synergies, and thus opportunities to deliver the SDGs more efficiently. Finding 2: '*There exist more interactions incoming SDG2, compared to interactions outgoing SDG2*' and finding 4: '*Most frequent interactions incoming SDG2 depart from SDG4, SDG8, SDG13'* inform that efforts to achieve SDG4, SDG8 and SDG13 impact the delivery of SDG2 and thus receive attention. Finding 5: '*Most frequent interactions outgoing SDG2 are directed to SDG15, SDG3 and SDG8'* informs that in making progress on the delivery of SDG2, attention should be given on the impacts efforts can have on SDG15, SDG3 and SDG8. Finding 6: '*No interactions exist between SDG2 and SDG11 & SDG14'* inform that in this context no opportunities of threats exist in delivering SDG2, SDG11 and SDG14. Finding 3: 'More interactions exists regarding target 2.3 and 2.4 compared to targets 2.1, 2.2 and 2.5' informs that focus should be put on targets 2.3 and 2.4. In the incidence of a trade-off regarding target 2.3 policymakers and other experts should be very cautious when aiming to deliver target 2.3 in this context, because of the existence of 10 trade-offs outgoing target 2.3 towards targets of SDG5, SDG6, SDG8 and SDG15, according to the structured literature review. Trade-offs are mainly arising when efforts to increase production including commercialization and intensification processes are stimulated and gender aspects (SDG5), challenges regarding water security (SDG6), shifts regarding employment and job opportunities (SDG8) and sustainable resource management, specifically regarding land, soil and forests are not considered and/or addressed.

The integrated approach of the SDG framework by having goals on the broad range of development objectives allows for a holistic approach to sustainable development. This study only focused on interactions between SDG2 and other SDGs. It is certain that a great deal of interactions exists between the different SDGs. So, the identified interactions between SDG2 and other targets in this study should not be seen on their own, but be part of a large network of targets. This is essential, as efforts to deliver a specific SDG do not only directly affect other SDGs, but also the SDGs connected to the affected SDG. Besides identifying interactions between two targets, Pham-Truffert et al., (2019) identified strongly interconnected SDG targets as critical sub-networks as well as systematic loops, existing of three or more targets. It is very plausible that alongside the virtuous cycles of target 2.4, 8.1, 13.4 and 15.2 more virtuous cycles exist regarding the identified interactions. Yet, in order to identify these, the interactions between all SDGs should be identified. One way of investigating and identifying these cycles is by identifying the weighted degree of centrality and the multiplier effect. Identifying and designing policy interventions making use of these virtuous cycles is particularly interesting as policymakers can make use of these and implement the SDGs more effectively.

Identified loops of SDG interactions

For nine combinations of targets, the targets are interacting both ways. Figure 25 illustrates these loops categorised per target of SDG2. Regarding target 6.1, synergies are incoming target 2.1 while a trade-off is directed from target 2.1 towards targets 6.1 and 15.1. This can be explained by the dependence on water and natural resource in order to provide food security. Once food security is achieved in a way which puts more pressure on water and natural resources, it hampers the delivery of targets 6.1 and 15.1. Therefore, it is essential to think critically about the way food security is achieved, and that the demand for water sources and pressure on natural resources should be taken into account, in order for the SDGs to be implemented effectively.

Target 2.2 is interaction in two ways with one target of SDG4. This loop includes the synergies between ensuring free, equitable and quality primary and secondary education and ending malnutrition over the long term. Ending malnutrition is accompanied by children having improved cognitive function and school performance. On the other hand, mothers which had access to school are found to have better knowledge regarding nutrition.

Regarding target 2.3, two synergies are incoming target 2.3. Achieving full employment and equal pay for equal work (target 8.5) and ending land degradation (target 15.3) contributed to the delivery of increased agricultural production and income. While increasing productivity by means of intensification and commercialization impedes achieving full employment and combatting land degradation. At the same time, when increased productivity in dairy production is achieved sustainably, it has a synergetic relationship with combatting land degradation (target 15.3) as fewer resources are needed to produce the same quantity of milk. With higher levels of education completed, it can result in two interactions. On the

one hand, farmers with higher levels of education completed are found to be more productive (synergy). On the other hand, farmers with higher levels of education are found to be less productive as they are more engaged in off-farm activities. A synergy is outgoing target 2.3 towards target 4.1 as increased productivity and income of farmers enables the households to send their children to school.

Regarding target 2.4, three synergetic loops are identified. Target 8.4, 13.1 and 15.2 are all concerned with sustainable and resilient food production and sustainable management of natural resources. Because of these three synergetic loops, efforts to achieve any of these targets will contribute to the delivery of all targets. The interactions between targets 8.4, 13.1 and 15.2 are not investigated but because they are all interacting both ways with target 2.4, this study confirms the indirect interactions between these targets. In literature, these reinforcing systemic loops are referred to as virtuous cycles (Pham-Truffert et al., 2019).

No interactions and no loops of interactions are identified regarding target 2.5.
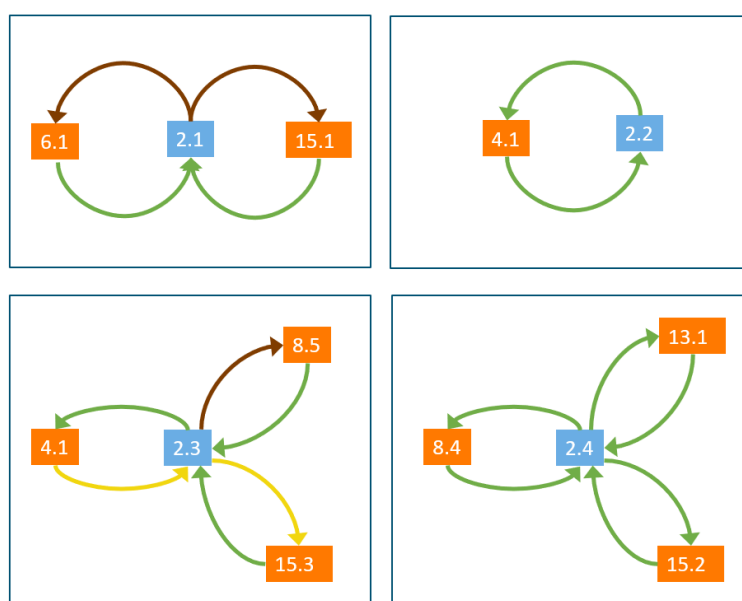
Figure 25: Illustration of identified two-way interactions/loops, categorised per target of SDG2 (own representation)

5.1.2 Contextual aspect of SDG interactions

Comparing SDG interactions in general and in this context

Comparing the results of this contextual study with a study which identified SDG interactions in general, the point of Bornemann & Weiland (2021), Nilsson et al. (2016), Fader et al. (2019) and Weitz et al. (2017) that SDG interactions are highly contextual, is confirmed. This study investigated the interactions between SDG2 and other SDGs in a specific geographic and sectoral context. Previously, Pham-Truffert et al., (2019) have identified SDG interactions at the target level in general. They assessed 65 global scientific assessments and UN flagship reports and 112 relevant scientific articles, to identify interactions between

SDG targets. Table 33 contains the number of interactions found between SDG2 and other SDGs in the context of dairy production in Kenya in this study, compared to the interactions identified between SDG2 and other SDGs in general by Pham-Truffert et al. This study identified 44 interactions which are not identified by Pham-Truffert et al., while Pham-Truffert et al., identified 222 interactions which are not identified in this study. For example, no trade-offs outgoing SDG2 towards SDG5 are identified by Pham Truffert et al., (2019), only synergies. In this study, no synergies but two trade-offs are identified outgoing SDG2 toward SDG5. The contextual characteristics, specifically regarding the position of women in households, explain the identified trade-offs between these two targets. Thus, studying SDG interactions in general, and not in a specific context, is unable to point out this specific trade-off. Unawareness regarding these interactions would lead to the implantation of an effort to achieve SDG2 with negative consequences on the delivery of SDG5, and real-life problematic impacts on the position of women in Kenya. Based on this brief comparison this study confirms that the interactions between the SDGs are highly contextual.

Table 33: Comparison of the number of interactions identified between SDG2 and other SDGs in this study and in the study of Pham-Truffert et al. (2019)

SDG	Total identified interactions this study	Identified in this study and by Pham-Truffert et al. (2019)	Identified in this study and not by Pham-Truffert et al. (2019)	Identified by Pham-Truffert et al. (2019) and not in this study	Total identified interactions by Pham-Truffert et al. (2019)
SDG1	6	3	3	23	26
SDG3	5	3	2	18	21
SDG4	10	1	9	4	5
SDG5	6	1	5	26	27
SDG6	8	5	3	29	34
SDG7	2	2	0	25	27
SDG8	10	1	9	8	9
SDG9	4	1	3	9	10
SDG10	3	1	2	7	8
SDG11	0	0	0	7	7
SDG12	7	2	5	8	10
SDG13	7	6	1	10	16
SDG14	0	0	0	20	20
SDG15	17	15	2	28	43
Total	86	41	44	222	263

Even within this study, some identified interactions only hold for specific contexts. This is largely attributable to the three different types of dairy production systems in Kenya; commercial dairy production, smallholder farming and pastoral livestock systems and the geographical location and resources available. For example, identified trade-offs between SDG2 and water security (SDG6) are present in a spatial context characterised by drought and water security. The challenge of water security

and drought differs per region in Kenya. In order for the universal approach of the SDG framework to deliver sustainable development everywhere, the varied challenges and circumstances should be accounted for (Yunita et al., 2022; Horner, 2020). This was confirmed by one expert which raised the need for more customisation of policies to diverse contexts regarding dairy production in Kenya.

Insights on contextual interactions via expert interviews

By conducting interviews with experts, light was shed on four themes in the context of dairy production in Kenya which help to understand the identified interactions based on the conducted structured literature review. First of all, the growing Kenyan population with their growing needs help explain the existing trade-offs between efforts to achieve food security (target 2.1) and ensuring drinking water for all (SDG6), efficient use of natural resources (SDG12) and conservation and protection of ecosystems and forests (SDG15).

Secondly, the experts described how agriculture is perceived as an unattractive field of work for younger generations. The current low prices and long working days in dairy production as well as the high amount of resources in order to start dairy production explain the interactions between SDG2 and SDG4 and SDG8. When higher levels of education are completed (SDG4), youth and current farmers are moving away from agriculture. Efforts to innovate in agriculture, to achieve full employment and decent work (SDG8) are likely to attract more youth into agriculture and thereby contribute to achieving SDG2.

Thirdly, experts addressed the lack of energy and poor infrastructure and how this influences the quality of the products, access to farm inputs and access to markets to sell the dairy products. Improving infrastructure (SDG9) and energy access (SDG7) contributes to achieving SDG2 as the cause of food insecurity according to experts arises regarding distribution challenges instead of production challenges.

Fourthly, in line with the results of the literature review, experts mentioned the role of women in dairy production and how empowerment projects should include men in the process in order to prevent them taking over the control of women and disempowering them.

These four trends and characteristics of dairy production in Kenya help to get a better understanding of the identified interactions between the targets of the SDGs. In addition, experts expressed the need to make a clear distinction between the three farming categories in Kenya, commercial dairy production, subsistence dairy production and pastoral livestock systems. It emphasized how different the livestock systems are and how interactions might exist in one context but not in the other.

Moreover, experts addressed two interactions which did not emerge in the structured literature review. Experts addressed the shift of households consuming more processed food instead of nutritious food once income and expenditure increase. Secondly, brought up the lack of access to financial markets for smallholder farmers and their reliance on family remittances.

5.1.3 Which SDG interactions to prioritise

To be able to provide recommendations to policymakers and implementation actors regarding which SDGs to focus on in order to deliver the 2030 agenda effectively, a weighing of the interactions is suggested. If one argues that the SDGs which interact the most with SDG2, (thus SDG15, SDG4 and SGD8) are the most important interactions to address in order to effectively implement the SDGs, this is in contradiction with the results of the ranking by experts. According to experts SDG13, SDG5, SDG1, SDG10 and SDG15 are the most important to address. It is surprising that no experts included SDG4 in their top 5 rankings nor that one of the experts is working on delivering SDG4 as many interactions exist between SDG4 and SDG2. No interactions exist between SDG2 and SDG11 and SDG14 in this context. This was confirmed during the interviews with the experts.

Bornemann and Weiland (2021) propose to choose the interactions to prioritise, based on the centrality of the SDG in the network. Because this study did only look at the interactions between SDG2 and other SDGs, no understanding is provided about the interactions between other SDGs. Therefore, with the results of this study, it is not possible to provide an overview of the centrality of the SDGs in the SDG network.

According to the ranking of the experts, the interactions between SDG2 with SDG13, SDG5, SDG1, SDG10 and SDG15 are most important to address in order to successfully and efficiently implement the SDGs. Based on the structured literature review, between SDG2 and SDG13, 7 interactions exist, between SDG2 and SDG5, 6 interactions exist, between SDG2 and SDG1 6 interactions exist, and between SDG2 and SDG10, 3 interactions exist. These SDGs have fewer interactions compared to SDG15, SDG4 and SDG8. Still, the exerts name these SDGs interactions as the most important to address. This implies that, for these experts, the amount of interactions does not determine the importance to address the SDG interactions. It might be determined by the beliefs and experiences of the experts, and the estimated impacts or valuation of the interactions by the experts. Applying this assumption to the current SDG implementation process, might explain current misaligned and segregated development efforts to deliver the SDGs. If experts and other actors work on the SDGs, or SDG interactions they believe are important to prioritize, there is a risk of neglecting the importance of other SDGs and the connectedness between all SDGs. When prioritizing certain SDGs over others, inevitably other SDGs are given less attention too. Yet, the numerous interactions identified in this study confirm the interconnectedness of the SDG framework and thus during prioritization of SDGs, it requires a holistic perspective and acknowledgement of the interconnectedness of the unprioritized SDGs in order to deliver the SDGs effectively.

5.1.4 Governing SDG interactions

Experts listed several points on how to better address SDG interactions. The need to improve capacity building was mentioned most often, by four experts. Two experts mentioned the need for I) increased sector alignment, II) science policy alignment, III) increased awareness of SDG interactions and IV)

increased actor interaction & alignment. Lastly, some points were mentioned only by one expert, I) aligning policy levels, II) customizing policies to the diverse contexts and III) improving enforcement of policies.

The answers raised by experts are not conflicting with each other and included numerous points of governance to improve in order to address SDG interactions effectively. The points raised for increased policy integration and alignment and the need for policies to be customized to the diverse contexts are also raised by previous researchers (Yunita et al., 2022; Biermann, Kanie & Kim, 2017; Horner, 2020). The need to increase capacity building was not raised by researchers before as a means to address SDG interactions. This could be the case as the need for increased capacity building is an mean to address the nature of the interactions existing in this context. So very much on the content of the SDG interactions. Probably the same holds for enforcement of policies in this context.

It is important to discuss and question the role of the function and experience experts have on the points they raise to answer the question, of what is needed in order to address SDG interactions. Policymakers mostly address the need to improve policies regarding integration etc. Academics address the need to better understand SDG interaction and call for a need for more science-policy engagement. A conservancy manager calls for the need for more conservation efforts and projects integrating development and conservation objectives. With the set of experts consulted this study, the perspective of Kenyan farmers and pastoralists perspective were not represented. Therefore, there are no insights on what according to farmers and pastoralists is needed in order to better address SDG interaction.

The need to improve policy integration was mentioned most often by experts to better address SDG interactions and deliver the SDGs. Policy formulation and implementation have been in strategy for years in Kenya to revitalise agriculture in Kenya: The Strategy for Revitalising Agriculture (SRA) and the Agricultural Sector Development Strategy (ASDS), but with limited results (Poulton and Kanyinga, 2014). *'Ethno-regional identities […] exert a strong influence on political allegiances'* (Poulton and Kanyinga, 2014. p. 168). People from the same ethnic group relate more with each other, despite differences in class, than people from the same class with different ethnicities. According to Poulton and Kanyinga (2014), this explains partly why still class-based forms of organisations which cross across all regions of Kenya are in place and why agricultural strategies to revitalise agriculture are not successful in delivering progress. No experts brought up the role of the ethno-regional identities during the experts' interviews. Therefore, future research should focus on how to address synergies and trade-offs and the political landscape where governance for SDG implementation is developed in order to contribute to the effective delivery of the SDG framework.

5.2 Limitations

In addition to the limitations section in the methodology chapter, this section raises additional limitations of this research. The first limitation of this study arises as only one individual has conducted this study. The identification process of SDG interaction conducting literature is subject to the interpretation of the

researcher. The definition of the SDGs and the targets are considered to be vague and can be interpreted differently by different individuals. Thus, the identification process of interactions between SDG targets using literature is subject to biases. The researcher's cognitive biases, identity and experiences affect the manner in which the SDGs are interpreted and SDG interactions are identified. A step to counter this bias is by employing multiple researchers in the identification process.

A second limitation is also a consequence of only one induvial conducting this study. Because of the interpretation bias present, this study did not adopt a typology to distinguish SDG interactions by nature. Various studies adopted a scoring typology developed by Nilsson et al. (2016) (ICSU, 2017; Pham-Truffert et al., 2020; Weitz, et al., 2014; Le Blanc, 2015; Mainali et al., 2018; Institute for Global Environmental Strategies, 2017). The typology ranges from -3 cancelling, ('The most negative interaction, where progress in one target makes it impossible to achieve another target and can lead to a deterioration of the second') to +3 indivisible ('The strongest form of positive interaction in which one target is inextricably linked to the achievement of another) (+3). The motivation to adopt this typology in other studies is that the degree of interactions between targets of SDGs differs. Despite the added value of adopting this scale, the choice was made not to include it as the identification of the degree and thus the score of the interaction would be done by one individual, inviting an interpretation bias. The lack of scoring SDG interactions in this study, causes this study to throw all identified interactions into the same pot.

A third limitation of this study is that it provides an understanding of interactions between SDG2 and other SDGs. The SDGs framework is considered a network of targets. This study only investigated the interactions between SDG2 and other SDGs, and therefore excludes the possible interactions between all other SDGs, for example between SDG5 'Gender equality' and SDG1 'No poverty'. By focussing on all interactions regarding SDG2 this study provided a thorough understanding of all SDG interactions in place between SDG2 and other SDGs. Yet, it must be taken in mind that much more other interactions are in place in the context of dairy production in Kenya. Additionally, the interactions between the targets of SDG2 were not investigated.

A fourth limitation of this study is that the ability to identify interactions between SDG2 and other SDGs in the chosen context is determined by the body of scientific literature available. It is not certain that for every combination of targets where no interactions were identified, no interactions exist. It could also be the result of certain topics and sets of SDGs in this context are understudied.

5.3 Implications

With these limitations in mind, it is possible to review the societal and scientific contributions of this study. This study has identified the interactions between the targets of SDG2 with other SDGs in the context of dairy production in Kenya, by conducting a structured literature review. Subsequently, these identified interactions were discussed with experts in the field as well as what according to them was needed to better address SDG interactions. By doing so, this study provides an understanding of the processes in place

regarding the implementations of the SDGs in a specific context. It created a clear overview of the opportunities and consequences when efforts to deliver SDGs are made. The identified synergetic interactions inform policymakers and developmental actors of the opportunities in SDG implementation to deliver the SDGs more effectively. Additionally, the identified trade-offs inform policymakers and developmental actors of the harm certain efforts to deliver a certain SDG can cause the delivery of other SDGs.

This study contributed to the understanding of the SDG framework of a network of targets and the degree of integration of the SDG targets. In adopting dairy production in Kenya as a context, this study has assisted in filling a gap in literature, as other scholars mainly investigated SDG interactions in general. By providing an overview of what needs to be governed in order to implement the SDGs effectively, this study functions to enable future research to investigate how the identified SDG interactions can and should be governed.

Chapter 6: Conclusion and Recommendations

6.1 Conclusion

This study aimed to answer the question: "*What interactions between sustainable development goal 2, and other the sustainable development goals exist in the context of dairy production in Kenya, and how can they be addressed?*". Based on qualitative and quantitative results from a structured literature review, semi-structured expert interviews and network analyses it draws the following conclusion. The structured literature review revealed that 85 interactions exist between the targets of SDG2 and other SDGs. The majority of these interactions are synergies (69). Efforts to achieve specific targets of SDG2, simultaneously contribute to the delivery of targets of other SDGs, 45 outgoing synergies were found. Additionally, progress on the delivery of targets of SDG2 is facilitated by efforts to achieve other SDGs and 24 incoming synergies. 16 identified interactions are trade-offs. Efforts to achieve specific targets of SDG2, hamper the delivery of targets of other SDGs, 13 trade-offs were found. Additionally, progress on the delivery of targets 2.1 and 2.3 is hampered by efforts to achieve targets of SDG1 and SDG4. Efforts to achieve specific targets of SDG2 have different impacts on the delivery of other SDGs. When looking at the interactions between SDG2 and other SDGs at the target level, most synergies arise regarding target 2.4 and most trade-offs arise regarding target 2.3. Few interactions exist regarding targets 2.1 and 2.2 with other SDGs and no interactions exist regarding 2.5. Within the set of identified interactions, nine combinations of targets are interacting in two ways and create a loop. For some combinations of targets, no interaction is identified yet this does not perse mean no interaction in the context of dairy production in Kenya exists. This could be the result of a lack of studies performed regarding the two targets within this context. The broad set of identified interactions supports the approach of the SDG framework as a network of targets which are interconnected. Furthermore, this study does confirm that SDG interactions are highly conceptual as the identified interactions in this study differ from the identified interactions of a study investigating the SDG interactions in general.

By conducting the interviews with experts, this study concludes that the discussed identified SDG interactions, were mostly recognised by experts. Through the expert interviews, a deeper understanding was provided regarding the contexts of the SDG interactions in place. The characteristics of and the challenges regarding dairy production in Kenya partly explain the presence of the identified SDG interactions. It must be taken in mind that not all identified interactions were discussed with experts and that the set of experts is unsuccessful in representing all different stakeholders in the Kenyan dairy sector.

Based on the insights of experts, the study concludes that capacity building, increased awareness of SDG interactions, increased actor interaction and policy integration and alignment are needed to better address SDG interactions. Specifically, policy integration is needed to align sectoral policies, policy levels

and policies with science, as well as to integrate policies serving diverse contexts and implement policy enforcement.

6.2 Recommendations

This subchapter presents recommendations for further research on SDG interactions and recommendations for policymakers and development actors in the Kenyan dairy sector inspired by the results of this study.

Recommendations for further research

For further research, this study has five recommendations. Firstly, this study recommends performing a similar study but in another geographical or sectoral context to allow for comparison. By doing so, a greater understanding will be provided of the role of contextual aspects in the existing SDG interactions.

Secondly, this study recommends studying the interactions between targets of a singular SDG. Taking SDG2 as an example; *How does target 2.3, doubling agricultural productivity interact with target 2.4 'Ensuring sustainable food production and resilient agricultural practices'*?. This study did not allow for investigation of possible interactions between targets of one SDG, yet their existence could impede or accelerate the delivery of the SDG at hand. Therefore, this should be investigated.

Thirdly, this study recommends expanding the study by identifying the SDG interactions between all targets in this context. By doing so, all interactions within the full network of targets are captured.

Fourthly, this study recommends applying the scoring matrix developed by Nilsson et al. (2016). This allows to distinguish the different levels of interactions between SDG targets.

Fifthly, this study recommends investigating what is needed to better address trade-offs and synergies in more detail as well as investigating the landscape in which policies and governance arrangements are designed for the purpose to gain more insights on what is needed to address SDG interactions.

Recommendations for policymakers and development actors in the Kenyan dairy sector

For policymakers and development actors in the Kenyan dairy sector, this study recommends spreading awareness of SDG interactions and the SDG framework as a network of targets. This study confirms the interconnectedness of the SDGs and their targets. When actors make efforts to deliver a specific SDG or target, they should be aware of and assess the direct and indirect effects these efforts might have on the delivery of other SDGs and targets. This assessment is recommended in order to prevent efforts to impede the delivery of other SDGs (trade-off) and make use of the opportunities to contribute to the delivery of multiple SDG targets at once. Because of the numerous trade-offs regarding target 2.3 'doubling agricultural productivity', specific attention should be given to the implantation efforts to deliver this target in order to prevent these hampering the delivery of other targets. Policymakers should make an effort to

design integrated policies to ensure alignment across policy levels, sectors and with science. Furthermore, policymakers should integrate policies serving diverse contexts and focus on enforcement and ownership of policies in order to address trade-offs and utilise synergies. Lastly, all actors involved in the Kenyan dairy sector should focus on the capacity building of farmers and strengthen the interactions with other actors in the field. By doing so, SDG interactions can be better addressed ensuring more efficient and effective delivery of the SDG agenda.

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Appendices

Appendix I: overview search terms

SDG1 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY (poverty OR "basic needs" OR "decent living" OR "living wage" OR "resilience of the poor" OR "poor households" OR "poor farmers")) AND PUBYEAR > 2011

Used December 13th, 2021

SDG3xSDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("human health" OR "well-being" OR "maternal mortality" OR "neonatal mortality" OR epidemics OR malaria OR tuberculosis OR aids OR "premature mortality" OR "mental health" OR "drug abuse" OR alcohol OR "traffic accidents" OR "road accidents" OR "reproductive health" OR "family planning" OR "health coverage" OR mortality) AND NOT TITLE-ABS-KEY ("zoonotic disease" OR "animal health" OR "cow disease" OR "breast milk")) AND PUBYEAR > 2011

Used December 13th, 2021

SDG4xSDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY (education OR illiteracy OR university OR "childhood development" OR literacy OR numeracy) AND NOT TITLE-ABS-KEY ("breast milk")) AND PUBYEAR > 2011

Used January 3rd, 2022

SDG5 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("women empowerment" OR gender)) AND PUBYEAR > 2011

Used January 11th, 2022

SDG6 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya

OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY (sanitation OR water)) AND PUBYEAR > 2011

Used January 11th, 2022

SDG7 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY (energy OR "electrification" OR electricity OR renewable OR solar OR coal OR wind OR biomass) AND NOT TITLE-ABS-KEY ("energy intake" OR "energy uptake")) AND PUBYEAR > 2011

Used January 18th, 2022

SDG8 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("economic growth" OR jobs OR "employment" OR "economic productivity" OR "modern slavery" OR "safe working environments" OR labour OR tourism OR labor OR "resource efficiency" OR entrepreneurship)) AND PUBYEAR > 2011

Used January 18th, 2022

SDG9 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY (infrastructure OR "innovation" OR "sustainable industries" OR "industrialization")) AND PUBYEAR > 2011

Used January 19th, 2022

SDG10 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("inequality" OR "vulnerable populations" OR "political inclusion" OR "equality" OR "enhanced representation" OR migration OR "mobility of people" OR "income growth" OR "social inclusion" OR "economic inclusion" OR empowerment OR representation)) AND PUBYEAR > 2011

Used January 21st, 2022

SDG11 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY (cities OR

urbanization OR city OR housing OR slums OR "public transport" OR road OR "natural heritage" OR "cultural heritage" OR "public spaces" OR "green spaces")) AND PUBYEAR > 2011

Used January 23rd, 2022

SDG12 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("responsible consumption" OR "responsible production" OR "sustainable consumption" OR "sustainable production" OR "natural resources" OR waste OR "public procurement" OR "sustainable practices" OR "sustainable development" OR chemicals)) AND PUBYEAR > 2011

Used January 24th, 2022

SDG13 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("climate change" OR "climate resilience" OR "natural disasters")) AND PUBYEAR > 2011

Used January 25th, 2022

SDG14 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("coastal ecosystems" OR overfishing OR marine OR oceans OR sea OR seas OR ocean)) AND PUBYEAR > 2011

Used January 25th, 2022

SDG15 x SDG2

(TITLE-ABS-KEY (food OR hunger OR "sustainable food production" OR nutrition OR malnutrition OR agriculture OR undernourishment OR starvation OR "agricultural productivity") AND TITLE-ABS-KEY (kenya OR kenyan) AND TITLE-ABS-KEY (dairy OR cow OR cattle OR milk) AND TITLE-ABS-KEY ("land management" OR deforestation OR desertification OR degradation OR ecosystems OR conservation OR biodiversity)) AND PUBYEAR > 2011

Used January 25th, 2022.

Thank interviewee in advance for their time and cooperation.

Ask if they wish to stay anonymous

Mention possibility to stop the interview at any moment

Mention duration of interview: 60 minutes

Ask permission for recording

Introduce myself

Introduction topic

For my master thesis, I am investigating the interactions between delivering different sustainable development objectives in the Kenyan dairy sector. I use the framework of the Sustainable Development Goals in this analysis (**Familiar with SDGs?**). It is relevant to understand these interactions as in many cases there are opportunities to make use of synergies to deliver sustainable development more effectively, as well as to prevent negative effects on other areas of sustainable development by understanding the existing trade-offs. As you are working on [CUSTOMISE TO INTERVIEWEE] I am very interested in hearing your insights on the interactions between the different sustainable development goals that affect projects in the Kenyan dairy sector, and how they are addressed.

Q1 Currently you are working on [NAME PROJECT]. Could you tell me something about how this project and your role in it?

Q2 When looking at the different SDGs, to which SDG would you say this project contributes?

Specific SDG interactions

SDG1: Present 3 selected interactions between SDG1 & SDG2

Q3 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG1 'no poverty' and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG3: Present selected interactions between SDG3 & SDG2

SDG2 x SDG3: Ensure healthy lives and promote well-being for all at all ages

Q4 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG3 and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG4: Present selected interactions between SDG4 & SDG2

SDG2 x SDG4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
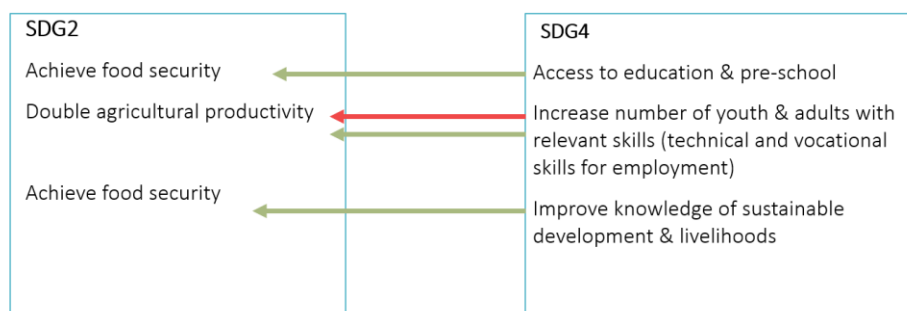
Q5 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG4 and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG5: Present selected interactions between SDG5 & SDG2

SDG2 x SDG5 Achieve gender equality and empower all women and girls

SDG2	SDG5
Achieve food security ←	Ensure equal opportunities & participation for women
Double agricultural productivity & increase income small holder farmers →	End discrimination & violence against women
Double agricultural productivity & increase income small holder farmers ←	Ensure equal opportunities & participation for women

Q6 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG5 and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG6: Present selected interactions between SDG6 & SDG2

SDG2 x SDG6 Ensure availability and sustainable management of water and sanitation for all

SDG2	SDG6
Achieve food security ← →	Access to safe& affordable drinking water
Ensure sustainable & resilient agricultural practices →	Increase water efficiency and management & protect water-related eco-systems
Ensure sustainable & resilient agricultural practices ←	Access to safe& affordable drinking water

Q7 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG6 and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG7: Present selected interactions between SDG7 & SDG2

SDG2 x SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all

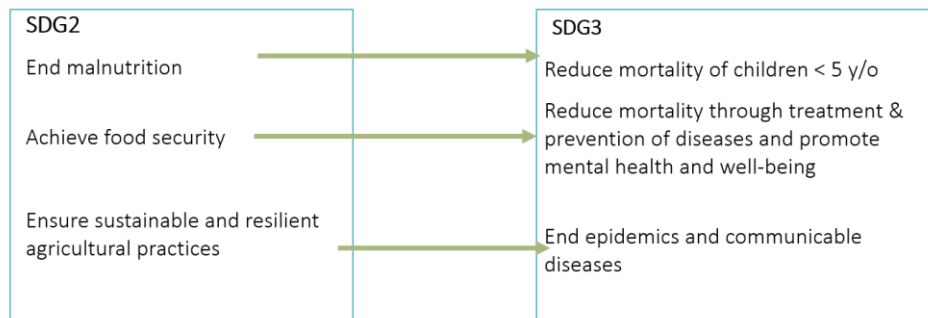| SDG2	SDG7
Achieve food security (quality) ←	Access to energy

Q8 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG7 and SDG2 'Zero hunger'?

- ➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
- ➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
- ➔ If No: would you expect particular interactions?

SDG8: Present selected interactions between SDG8 & SDG2

SDG2 x SDG8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

| SDG2	SDG8
Double agricultural productivity	Improve resource efficiency & decouple economic growth from environmental degradation
Ensured equal access to land & resources + ensuring sustainable and resilient agricultural practices	Achieve productive employment & reduce unemployment youth
Doubling agricultural productivity and ensured equal access to land and other productive resources	Achieving higher levels of economic productivity through the adaptation of innovations

Q9 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG8 and SDG2 'Zero hunger'?

- ➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
- ➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
- ➔ If No: would you expect particular interactions?

SDG9: Present selected interactions between SDG9 & SDG2

SDG2 x SDG9 build resilient infrastructure, promote sustainable industrialization and foster innovation

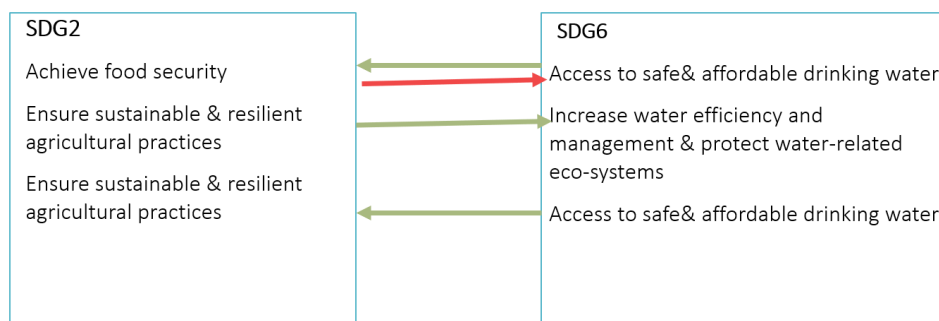| SDG2	SDG9
Increase income small holder farmers	Develop reliable infrastructure
Ensure sustainable & resilient agricultural practices	Increase access to financial services

Q10 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG9 and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG2 x SDG10: Reduce inequality within and among countries

SDG2	SDG10
Double agricultural productivity & increase income small holder farmers	Promote social, political & economic inclusion of all
Double agricultural productivity & increase income small holder farmers	Ensure equal opportunities
Double agricultural productivity & increase income small holder farmers	Adopt wage and social protection policies to achieve greater equality

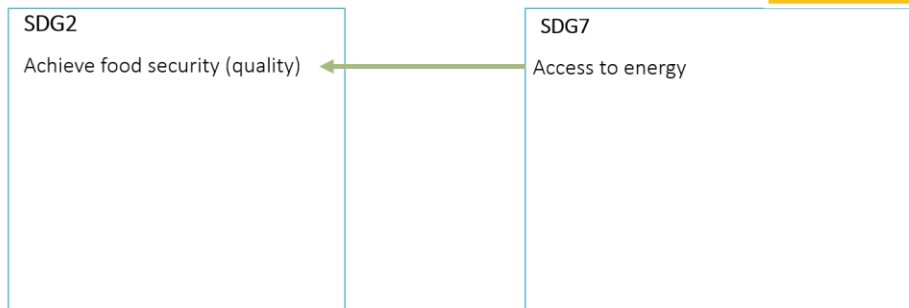**SDG10:** Present selected interactions between SDG10 & SDG2

Q11 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG10 and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG12: Present selected interactions between SDG12 & SDG2

SDG2 x SDG12: Ensure sustainable consumption and production patterns

SDG2

Achieve food security

Ensure sustainable & resilient agricultural practices

SDG12

Sustainable management of natural resources
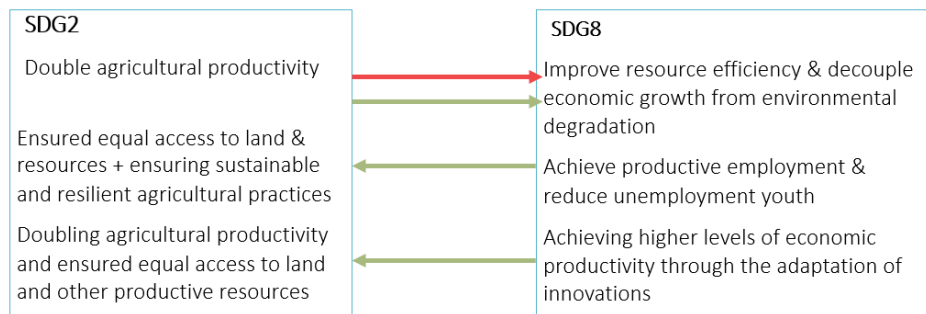
Sustainable management of natural resources
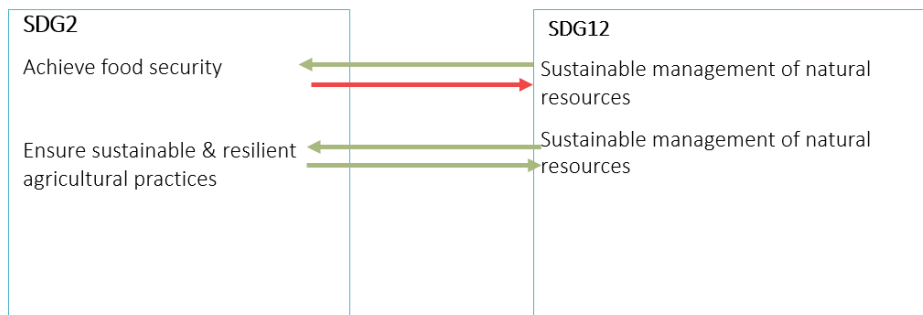
Q12 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG12 and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG13: Present selected interactions between SDG13 & SDG2

SDG2 x SDG13: Take urgent action to combat climate change and its impacts

SDG2

Achieve food security

Double agricultural productivity & increase income small holder farmers

Ensure sustainable & resilient agricultural practices

SDG13

Strengthen resilience to climate-related hazard & natural resilience

Strengthen resilience to climate-related hazard & natural resilience

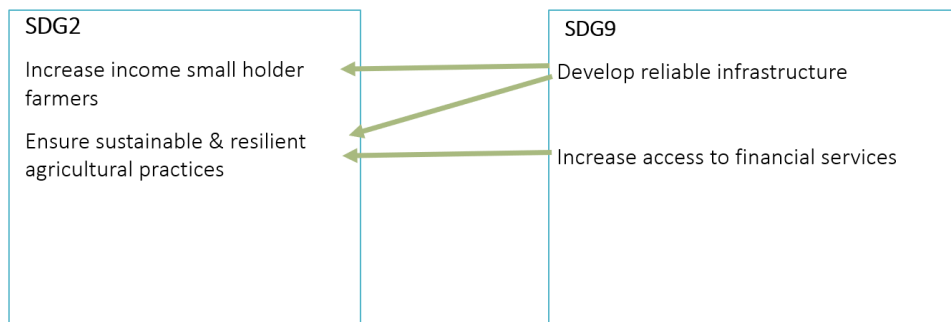Improve education on climate change mitigation & adaptation

Q13 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG# and SDG2 'Zero hunger'?

➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
➔ If No: would you expect particular interactions?

SDG15: Present selected interactions between SDG15 & SDG2

SDG2 x SDG15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15 LIFE ON LAND

SDG2	SDG15
Ensure sustainable & resilient agricultural practices	Sustainable manage forests
Double agricultural productivity & increase income small holder farmers	Combat desertification & reduce degradation of natural habitats & halt loss of biodiversity

Q14 Now I have presented three identified interactions based on my conducted literature review, do you recognize or have you experienced a synergy or trade-off between SDG# and SDG2 'Zero hunger'?

- ➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
- ➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
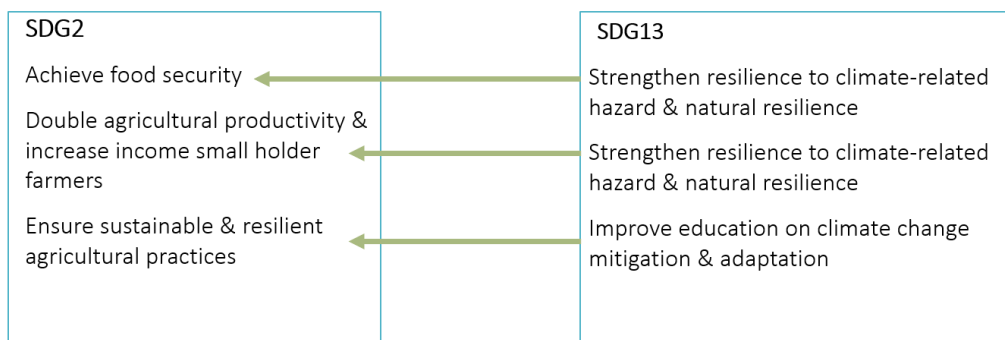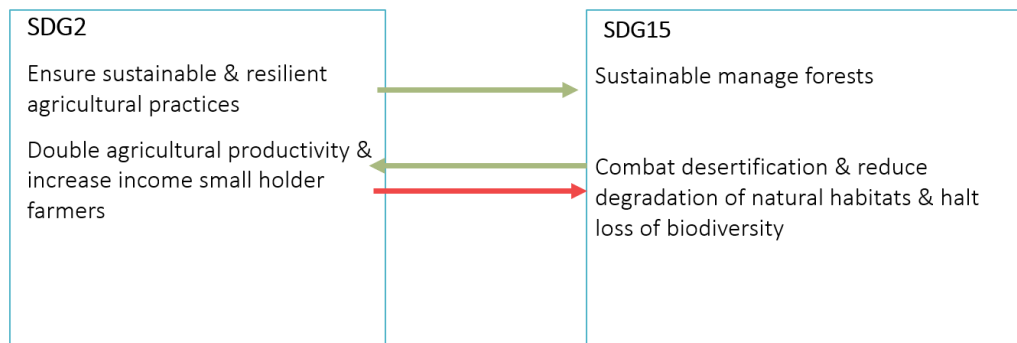- ➔ If No: would you expect particular interactions?

SDG11

Q15 No interactions were identified between the targets of SDG2 with the targets of SDG11, have you experienced one, or would expect one?

- ➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
- ➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
- ➔ If No: would you expect particular interactions?

SDG14

Q16 No interactions were identified between the targets of SDG2 with the targets of SDG14, have you experienced one, or would expect one?

- ➔ if yes trade-off ➔ Did the project address these trade-offs? if so how?
- ➔ if yes synergy ➔ Did the project utilize these synergies? if so how?
- ➔ If No: would you expect particular interactions?

Additional questions

Q17 Of all discussed SDG interactions, could you rank the five interactions which according to you are the most important/relevant synergies in the context of the Kenyan livestock sector? and why?

Q18 What according to you is needed to better address trade-offs and utilize synergies in the Kenyan livestock sector more effectively?

Closing

Ask again if they wish to stay anonymous

Provide the possibility to ask questions

Explain follow up with results of this interview & thesis in general

Provide contact details

Thank again

Appendix III: literature results sources

SDG1

Aizawa, T. (2020). Do cash transfers increase nutritional intakes? experimental evidence from an unconditional cash transfer in Kenya. Health Policy and Planning, 35(7), 784-798. doi:10.1093/heapol/czaa030

Marsh, T. L., Yoder, J., Deboch, T., McElwain, T. F., & Palmer, G. H. (2016). Livestock vaccinations translate into increased human capital and school attendance by girls. Science Advances, 2(12) doi:10.1126/sciadv.1601410

Ngigi, M. W., Mueller, U., & Birner, R. (2021). Livestock diversification for improved resilience and welfare outcomes under climate risks in Kenya. European Journal of Development Research, 33(6), 1625-1648. doi:10.1057/s41287-020-00308-6

Oyekale, A. S. (2013). Factors explaining dairy cattle adoption behaviour among smallholder farmers in Kenya. Asian Journal of Animal and Veterinary Advances, 8(7), 893-903. doi:10.39231ajava.2013.893.90

Wyatt, A. J., Yount, K. M., Null, C., Ramakrishnan, U., & Webb Girard, A. (2015). Dairy intensification, mothers and children: An exploration of infant and young child feeding practices among rural dairy farmers in Kenya. Maternal and Child Nutrition, 11(1), 88-103. doi:10.1111/mcn.12074

SDG3

Colleen, W., VanLeeuwen, J., MacLellan, D., Taylor, J., & Mbugua, S. (2017). Effect of nutrition education and dairy group membership on nutrition knowledge, practices and diet quality for rural kenyan farm women. African Journal of Food, Agriculture, Nutrition and Development, 17(3), 12343-12361. doi:10.18697/ajfand.79.15350

Marsh, T. L., Yoder, J., Deboch, T., McElwain, T. F., & Palmer, G. H. (2016). Livestock vaccinations translate into increased human capital and school attendance by girls. Science Advances, 2(12) doi:10.1126/sciadv.1601410

Masiaine, S., Pilfold, N., Moll, R. J., O'connor, D., Larpei, L., Stacy-Dawes, J., . . . Montgomery, R. A. (2021). Landscape-level changes to large mammal space use in response to a pastoralist incursion. Ecological Indicators, 121 doi:10.1016/j.ecolind.2020.107091

Ndungi, F., Muliro, P., Faraj, A., & Matofari, J. (2021). Milk handling practices and utilization at dairy farms and collection centers under rural and peri-urban milk value chain systems in nakuru county, kenya. African Journal of Food, Agriculture, Nutrition and Development, 21(4), 17815-17833. doi:10.18697/ajfand.99.20080

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Omara, T., Kiprop, A. K., Wangila, P., Wacoo, A. P., Kagoya, S., Nteziyaremye, P., . . . Baker Obakiro, S. (2021). The scourge of aflatoxins in kenya: A 60-year review (1960 to 2020). Journal of Food Quality, 2021 doi:10.1155/2021/8899839

Oyas, H., Holmstrom, L., Kemunto, N. P., Muturi, M., Mwatondo, A., Osoro, E., . . . Njenga, M. K. (2018). Enhanced surveillance for rift valley fever in livestock during el niño rains and threat of RVF outbreak, kenya, 2015-2016. PLoS Neglected Tropical Diseases, 12(4) doi:10.1371/journal.pntd.0006353

SDG4

Chege, P. M., Kimiywe, J. O., & Ndungu, Z. W. (2015). Influence of culture on dietary practices of children under five years among maasai pastoralists in kajiado, kenya. International Journal of Behavioral Nutrition and Physical Activity, 12(1) doi:10.1186/s12966-015-0284-3

Colleen, W., VanLeeuwen, J., MacLellan, D., Taylor, J., & Mbugua, S. (2017). Effect of nutrition education and dairy group membership on nutrition knowledge, practices and diet quality for rural kenyan farm women. African Journal of Food, Agriculture, Nutrition and Development, 17(3), 12343-12361. doi:10.18697/ajfand.79.15350

Cornelsen, L., Alarcon, P., Häsler, B., Amendah, D. D., Ferguson, E., Fèvre, E. M., . . . Rushton, J. (2016). Cross-sectional study of drivers of animal-source food consumption in low-income urban areas of nairobi, kenya. BMC Nutrition, 2(1) doi:10.1186/s40795-016-0109-z

Hotz, C., Pelto, G., Armar-Klemesu, M., Ferguson, E. F., Chege, P., & Musinguzi, E. (2015). Constraints and opportunities for implementing nutrition-specific, agricultural and market-based approaches to improve nutrient intake adequacy among infants and young children in two regions of rural kenya. Maternal and Child Nutrition, 11, 39-54. doi:10.1111/mcn.12245

Hulett, J. L., Weiss, R. E., Bwibo, N. O., Galal, O. M., Drorbaugh, N., & Neumann, C. G. (2014). Animal source foods have a positive impact on the primary school test scores of kenyan schoolchildren in a cluster-randomised, controlled feeding intervention trial. British Journal of Nutrition, 111(5), 875-886. doi:10.1017/S0007114513003310

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Makau, D. N., VanLeeuwen, J. A., Gitau, G. K., Muraya, J., McKenna, S. L., Walton, C., & Wichtel, J. J. (2018a). Animal and management factors associated with weight gain in dairy calves and heifers on smallholder dairy farms in kenya. Preventive Veterinary Medicine, 161, 60-68. doi:10.1016/j.prevetmed.2018.10.017

Makau, D. N., Vanleeuwen, J. A., Gitau, G. K., Muraya, J., McKenna, S. L., Walton, C., & Wichtel, J. J. (2018b). Effectiveness of using cellphone technology as a dairy management training tool for smallholder dairy farms in kenya. Livestock Research for Rural Development, 30(11)

Marsh, T. L., Yoder, J., Deboch, T., McElwain, T. F., & Palmer, G. H. (2016). Livestock vaccinations translate into increased human capital and school attendance by girls. Science Advances, 2(12) doi:10.1126/sciadv.1601410

Nyokabi, S., Birner, R., Bett, B., Isuyi, L., Grace, D., Güttler, D., & Lindahl, J. (2018). Informal value chain actors' knowledge and perceptions about zoonotic diseases and biosecurity in kenya and the importance for food safety and public health.

Wyatt, A. J., Yount, K. M., Null, C., Ramakrishnan, U., & Webb Girard, A. (2015). Dairy intensification, mothers and children: An exploration of infant and young child feeding practices among rural dairy farmers in kenya. Maternal and Child Nutrition, 11(1), 88-103. doi:10.1111/mcn.12074

SDG5

Bullock, R., & Crane, T. (2021). Young women's and men's opportunity spaces in dairy intensification in Kenya. Rural Sociology, 86(4), 777-808. doi:10.1111/ruso.12385

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Maindi, N. C., Osuga, I. M., & Gicheha, M. G. (2020). Advancing climate smart agriculture: Adoption potential of multiple on-farm dairy production strategies among farmers in Murang'a county, kenya. Livestock Research for Rural Development, 32(4)

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Tavenner, K., Crane, T. A., & Saxena, T. (2021). "Breaking even" under intensification? gendered trade-offs for women milk marketers in kenya*. Rural Sociology, 86(1), 110-138. doi:10.1111/ruso.12345

Waithanji, E., Njuki, J., Mburu, S., Kariuki, J., & Njeru, F. (2015). A gendered analysis of goat ownership and marketing in meru, kenya. Development in Practice, 25(2), 188-203. doi:10.1080/09614524.2015.1002453

SDG6

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Carbonell, V., Merbold, L., Díaz-Pinés, E., Dowling, T. P. F., & Butterbach-Bahl, K. (2021). Nitrogen cycling in pastoral livestock systems in sub-saharan africa: Knowns and unknowns. Ecological Applications, 31(6) doi:10.1002/eap.2368

Heller, M. C., Walchale, A., Heard, B. R., Hoey, L., Khoury, C. K., De Haan, S., . . . Jones, A. D. (2020). Environmental analyses to inform transitions to sustainable diets in developing countries: Case studies for vietnam and kenya. International Journal of Life Cycle Assessment, 25(7), 1183-1196. doi:10.1007/s11367-019-01656-0

Maindi, N. C., Osuga, I. M., & Gicheha, M. G. (2020). Advancing climate smart agriculture: Adoption potential of multiple on-farm dairy production strategies among farmers in Murang'a county, kenya. Livestock Research for Rural Development, 32(4)

Nyokabi, S., Luning, P. A., de Boer, I. J. M., Korir, L., Muunda, E., Bebe, B. O., . . . Oosting, S. J. (2021). Milk quality and hygiene: Knowledge, attitudes and practices of smallholder dairy farmers in central kenya. Food Control, 130 doi:10.1016/j.foodcont.2021.108303

Rosinger, A. Y., Bethancourt, H., Swanson, Z. S., Nzunza, R., Saunders, J., Dhanasekar, S., . . . Pontzer, H. (2021). Drinking water salinity is associated with hypertension and hyperdilute urine among daasanach pastoralists in northern kenya. Science of the Total Environment, 770 doi:10.1016/j.scitotenv.2020.144667

Warinda, E., Nyariki, D. M., Wambua, S., Muasya, R. M., & Hanjra, M. A. (2020). Sustainable development in east africa: Impact evaluation of regional agricultural development projects in burundi, kenya, rwanda, tanzania, and uganda. Natural Resources Forum, 44(1), 3-39. doi:10.1111/1477-8947.12191

SDG7

Foster, R., Jensen, B., Dugdill, B., Knight, B., Faraj, A., Mwove, J. K., & Hadley, W. (2015). Solar milk cooling: Smallholder dairy farmer experience in kenya. Paper presented at the ISES Solar World Congress 2015, Conference Proceedings, 1670-1679. doi:10.18086/swc.2015.03.05

Foster, R., Jensen, B., Faraj, A., Mwove, J. K., Dugdill, B., Knight, B., & Hadley, W. (2017). Direct drive photovoltaic milk chilling: Two years of field experience in kenya. Paper presented at the ISES Solar World Congress 2017 - IEA SHC International Conference on Solar Heating and Cooling for Buildings and Industry 2017, Proceedings, 932-941. doi:10.18086/swc.2017.16.02

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Appendix IV: Elaboration on identified SDG interactions

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG1: 'No poverty'

S1a Multiple studies imply a synergetic relationship between eradicating poverty (1.2) with improved food security (2.1) (Marsh, Yoder, Deboch, McElwain & Palmer, 2016; Ngigi, Mueller, Birner, 2021; Aizawa. 2020 and Oyekala, 2013). All studies describe that in cases of increases in income among poor households, total expenditure on food items increases and specifically expenditure on milk and milk products.

T1a One potential trade-off between target 2.2 and SDG1 was identified. Wyatt et al. (2015) note that in some cases efforts to eradicate poverty (1.2) by increasing agricultural production (2.3) have a negative effect on preventing forms of malnutrition amongst infants and children (2.2). In the case of intensified dairy production, the demand for women's time and workload increases. This, in some cases, results in women introducing water or cow's milk into their child's diet at an earlier age, compared to women from households who do not adopt dairy intensification strategies. The introduction of water or cow's milk instead of breast milk to infants is concerning as infants 'digestion systems are not mature enough to process liquids other than breast milk. Thus, in this case, attempts to achieve target 1.2 by increasing productivity (2.3) might result in a trade-off with achieving target 2.2; preventing forms of malnutrition amongst infants and children.

S1b One synergy was identified between target 1.5 with target 2.1. Ngigi, Mueller and Birner (2021) found that when farmers reduce their vulnerability to climate-related extreme events by improving their ability to cope and recover from shocks (1.5), farmers are able to sustain or even improve food security (2.1) as income is secured and there are fewer production losses due to resilience.

S1c One synergy was identified between target 2.3 and SDG1. Marsh, Yoder, Deboch, McElwain & Palmer (2016) found that livestock vaccination increases milk production and income as animal diseases and animal mortality decrease. Farmer households were found to spend the surplus profit on childhood education and food purchase. Thus, according to this study, a synergetic interaction exists between increasing agricultural productivity (2.3) with increased income and poverty reduction (1.2). This implied synergetic interaction is reinforced by the study by Oyekale (2013) and Wyatt et al., (2015). Oyekale (2013) states that cattle play a significant role in household livelihood as a means for food and nutrition provision, income, assets and storage of wealth. According to the authors, due to these different roles of cattle, increases in milk yields (2.3) has synergetic effects on realising poverty reduction (1.2).

S1d Furthermore, an interaction was identified between targets 2.4 and 1.2. Oyekale (2013) and Wyatt et al., (2015) conclude that due to the adoption of resilient agricultural practices and ensuring sustainable food production systems (2.4) poverty levels were found to be reduced (1.2).

S1E. Ngigi, Mueller and Birner (2021) find that diversification of livestock strengthens livelihood resilience through improved ability to cope and recover from shocks, resulting in improved income and reduced poverty levels of farmers. Thus, by implementing resilient agricultural practices (2.4), farmers reduce their vulnerability to climate-related extreme events (1.5). Therefore, a synergetic relationship exists between 2.4 and 1.5.

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG3: 'Good Health and Well-being'

S3a & S3c Two synergies were identified between target 2.1 and SDG3. Ending the consumption of unsafe food and achieving access for all to safe, nutritious and sufficient food all year round (2.1) was found to have a synergetic relationship with preventing premature mortality (3.4) and ending preventable deaths of new-borns and children under 5 years of age (3.2) in the context of dairy consumption in Kenya (Omara et al., 2021; Ndungi, Muliro, Faraj and Matofari, 2021; Masiaine, Pilfold, Moll, Roloff and Montgomery, 2021). Omara et al. (2021) came to this conclusion when reviewing the scourge of aflatoxins which are toxins produced by fungi and can be found on agricultural crops. When people consume contaminated plant products or contaminated meat or dairy from animals which ate contaminated feed, people are exposed to aflatoxins. Exposure to aflatoxins is associated with an increased risk of cancer. Furthermore, intake of low, daily doses of aflatoxins by infants and young children results in impaired food conversion, stunting, cancer and a reduced life expectancy. According to the authors, unsafe food consumption, in this case, the consumption of aflatoxin-contaminated food, results in child malnutrition, reduced life expectancy and increases the risk of cancer. In Kenya, ensuring safe and nutritious food (2.1) by producing quality milk is difficult in cases of poor hygiene and sanitation, unclean water, high temperatures, lack of cooling facilities during the milk handling process and inadequate infrastructure for milk transportation (Ndungi et al., 2021). Ndungi et al., (2021) investigated different quality tests carried out on raw milk. Quality tests are performed on raw milk as many diseases are transmissible via milk posing threats to human health and the quality affects its shelf-life. Providing children and adults with unsafe milk poses a risk to child health (3.2) and human health and well-being (3.4). In the study, by testing milk samples of 177 different farmers, 24.9% was unsafe milk. The authors bring forth that the use of reusable towels was significantly associated with milk contamination. Due to the negative impacts of consuming unsafe milk on human health, a one-way synergetic relationship exists between ensuring safe and nutritious milk (2.1) and achieving ending child mortality (3.2) and improving health and well-being (3.4).

S3b One synergy was found between target 2.4 and SDG3. Oyas et al. (2018) investigated Rift Valley Fever (RVF), which is a mosquito-borne viral zoonoses affecting cattle primarily. The disease spills over to humans through close contact with the blood and organs of infected animals or through bites from an infected mosquito. Infection for livestock implies often death. Over 80% of infected humans are asymptomatic or have mild influenzas-like illnesses. Yet, in some outbreaks high morbidity and mortality has been reported, outbreak in Kenya in 1997-1998. The authors state that livestock RVF epidemics are closely linked with

heavy rainfall which occurs during the warm phase of El Niño. The authors investigated how an enhanced surveillance system functioned as an early warning system that could defect Rift Valley Fever (RVF) epidemics in Eastern Africa. The trial of the early warning system can be seen as an attempt to implement more resilient agriculture (2.4). This effort to make the dairy sector in Kenya more resilient to RVF outbreaks is according to the authors, likely to simultaneously contribute to ending epidemics and communicable diseases (3.3).

S3d One synergy was found between target 2.2 and SDG3. Ending malnutrition (2.2) was found to have a synergetic relationship with ending premature mortality (Colleen, Van Leeuwen, MacLellan, Taylor and Mbugua, 2017). Colleen et al., (2017) investigated the effects of a nutrition education intervention on nutrition knowledge, practices, and diet quality of members of a dairy group for smallholder farmers in Kenya. The authors state that the high-starch, low diversity diet in developing countries is associated with malnutrition and premature mortality. Attempts to end malnutrition (2.2) will contribute to the achievement of target 3.4, ending premature mortality and improving well-being. Specifically, strategies regarding food and education regarding nutrition are brought forth by the authors as the appropriate and sustainable strategies to prevent micronutrient deficiencies and improve health, in resource-poor areas. In these areas access to health services and supplements is limited.

S3e A synergy was found between target 2.3 with target 3.4 by Masiaine et al., (2021). The authors investigated the livelihoods of pastoralists in Kenya. Pastoralists suffer the consequences of increased conflict between their cattle and wildlife. Because the milk production of their cattle is mostly for their own consumption, decreases in production, as a result of conflicts with wildlife has negative effects on human health outcomes and thus halt reducing premature mortality and improving well-being (3.4). Efforts to prevent conflicts between pastoralist livestock with wildlife will increase production (2.3) and are likely to simultaneously contribute to the achievement to improve well-being (3.4).

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG4: 'Quality Education'

S4a Kariuki et al. (2017) describe a link between the level of education completed by the women and the intake of nutrients within the household. This finding implies a synergy between improving school attendance (4.1) and food security (2.1).

S4b Kirui et al. (2017) and Hotz et al. (2015) identified a link between the level of education and knowledge of nutrition. An increase in the level of education (4.1) completed will contribute to the achievement of ending malnutrition (2.2), according to their studies. Yet, Hotz et al. (2015) stress that unless access to nutritious food is not improved, the impact of education alone may be limited (4.1).

S4c Makau et al. (2018) identified a link between completing secondary education and the average daily weight gain of calves. Therefore, increasing the number of students who complete secondary education (4.1) may be a route to greater dairy animal productivity (2.3).

T4a Makau et al. (2018) found that farmers which completed higher education had calves with a lower average daily weight gain, perhaps due to the farmers' involvement in off-farm activities. Therefore, this study implies a synergy and trade-off between the level of education completed (4.1) and agricultural productivity (2.3).

S4d Makau et al. (2018b) investigated the impact of improving agricultural education in the form in the form of education on and adoption of cell phone technology tools. It was found that this technology increases productivity. Therefore, a synergy between increasing the number of technical skills relevant to employment (4.4) and agricultural productivity (2.3) was identified.

S4e One synergy was identified between target 2.4 & SDG4. Nyokabi et al. (2018) found that when the level of relevant skills for employment increases, farmers are more likely to adopt resilient agricultural practices. Therefore there exist a synergy between improving relevant skills for employment (4.4) and delivering resilient agricultural practices (2.4).

S4f Kimani et al. (2021) found that education on sustainable development and lifestyle improves understanding of zoonotic diseases in Kenya. According to the authors, this is likely to result in the provision of more productive and safe food and thus more productive and safe food provision. Therefore, efforts to improve education regarding sustainable lifestyles (4.7) simultaneously contribute to the delivery of delivery food security (2.1).

S4g A synergy was found between targets 2.2 and 4.7. Chege, Kimiywe, and Ndungu (2015) describe that among pastoralists there are incidences of malnutrition as well as low levels of knowledge regarding sustainable dietary practices. The authors bring forth improving education regarding sustainable lifestyle as a means to improve knowledge on dietary practices. According to the authors, efforts to improve knowledge regarding sustainable lifestyles and dietary practices (4.7) are likely to improve food intake and therefore combat malnutrition (2.2). This strategy is also brought forth by Kariuki et al. (2017). The authors concluded that providing nutrition education (4.7) among women with low education may help overcome unhealthy food taboos and improve dietary practices of pregnant women and their newborns (2.2). Wyatt et al. (2015) also identified this interaction and stress the importance of providing nutritious education which is culturally appropriate and sensitive to cultural beliefs. If culture is neglected the impact of providing nutritious education in combatting malnutrition is likely to be limited. Interestingly, Colleen et al. (2017) describe a synergy between target 2.2 with two other targets. The authors describe that combing

efforts to improve education regarding nutrition (4.7) and increasing productivity (2.3) is more successful in ending malnutrition (2.2) compared to not combining these types of education.

S4h A synergy was identified between targets 2.2 & 4.1. Cornelsen et al. (2016) investigated the demand for animal sources food products. The authors describe that when children consume more animal source products, dietary quality increases with a positive effect on cognitive outcomes. For undernourished children, increased consumption of milk and other animal source foods, improved anthropometric indices, cognitive function and school performance (4.1), while reducing morbidity and mortality. Therefore, efforts to combat malnutrition among children (2.2) also positively contribute to school performance (4.1). This finding is reinforced by the study of Hulett et al. (2014) who found that increases in milk intake by children increase cognitive functions.

S4i A synergy was identified between targets 2.3 and 4.1. Marsh et al. (2016) and Hotz et al. (2019) found that attempts to increase productivity are associated with increased expenditure on education and attendance of girls to school (4.1). Therefore, increases in agricultural productivity and farmer income (2.3) will contribute to the delivery of target 4.1 as attendance of girls to school increases.

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG5: 'Gender Equality'

S5a A synergy was identified between targets 5.1 with 2.3. Women are found to suffer more constraints in the livestock sector (Waithanji, et al., 2021). They are found to have limited access to resources and decisionmaking powers (2.3). Efforts to combat discrimination (5.1) are likely to increase production as well as the income of female farmers (2.3).

S5b One synergy was identified between target 2.1 & SDG5. Bullock and Crane (2015) Mwambi, Bijman and Galie (2021) and Galié et al. (2021) describe a synergy between targets 5.5 & 2.1. For female farmers in Kenya, the little money gotten from evening milk sales is the source of money women use to buy food items. The milk sales are important means for women to secure income to purchase food for their households (Bullock and Crane, 2021). Kalenjin women are described to have limited agency in owning or managing cows. Women's limited decision-making power regarding milk purchases can restrict their ability to provide sufficient milk (Galié et al., 2021). Bullock and Crane (2015) Mwambi, Bijman and Galie (2021) and Galié et al. (2021) describe that efforts to ensure women's full and effective participation and equal opportunities (5.5) for leadership at all levels will, in this context, increase ensuring nutritious and sufficient food (2.1). Furthermore, Galié et al. (2021) describe that including men in nutritional programming is very important as men often make key decisions at the household level including regarding food security. In some cases, women acquire the relevant knowledge but lack the agency to implement and make decisions. Including men in nutritional programming, according to the authors will be likely to result in improved consumed nutrition.

S5c A synergy was found between targets 5.5 & 2.3. It was found that if women have equal access to production resources and services as men, they can increase production on their farms by 20-30% (Mwambi, Bijman & Galie, 2021). By joining producer organizations women can increase their independent decision making power. The authors too described that joining producer organisations has negative effects on the decision making power as improved access to markets and technologies by joining producer organisations, commercialization occurs and this leads to the disempowerment of women as men take over control of the farm. This is in line with the founding of Waithanji, et al., (2021). The authors describe that women are found to have limited access to resources and decision-making powers (2.3) in the livestock sector. Efforts to increase the decision power of women (5.5) are likely to increase production as well as the income of female farmers (2.3). These articles thus imply a synergy between ensuring women's full and effective participation and equal opportunities (5.5) with increased agricultural production and commercialization (2.3).

S5d One synergy was identified between target 2.4 & SDG5. Maindi, Osuga and Gicheha (2020) found that the limited responsibility, access and control women have over land, labour and financial resources results in low incentives in uptake and intensification in the utilisation of climate-smart Agriculture. Thus, attempts to ensure equal opportunities for women (5.5) will positively impact delivering resilient and sustainable agriculture (2.4).

T5a A trade-off was identified between targets 2.3 and 5.2. In cases of increased milk yield of evening milk, women are at risk of losing control over evening milk sales as men take over (Tavenner, Crane and Saxena, 2021). In a group discussion of the study by Tavenner, Crane and Saxena, 2021) participants explained that men feel bad if their wives had succeeded in producing milk. They describe that women have to 'lie low' as their men don't appreciate succeeded of women and in some cases, this envy occurs in the form of domestic violence. Therefore, in some cases in this context, there exists a trade-off between increases in agricultural production (2.3) and incidences of violence against women (5.2).

T5b One trade-off was identified between targets 2.3 & 5.5. Bullock and Crane (2021) describe a trade-off between increasing agricultural productivity by means of intensification and commercialization and ensuring women's full and effective participation and equal opportunities (5.5). The authors describe that intensification and commercialization tend to further disenfranchise women. Mwambi, Bijman & Galie, (2021) and Waithanji, et al. (2021) too identified this trade-off in the case of commercialization and intensification on ensuring women's full and effective participation and equal opportunities (5.5).

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG6: 'Clean Water and Sanitation'

S6a A synergy was identified between targets 6.1 and 2.1. In dairy farming, milk contamination and unsafe food and nutrition result from improper handling and poor hygiene and sanitation in the dairy environment

(Nyokabi et al., 2021). In the Oljoro-Orok area farmers often used water which contained liver fluxes as a result of clean water scarcity. Increasing access to clean water decreases the risk of unsafe milk. Furthermore, when access to safe water increased, the adoption of milk quality hygiene practices increased as well. Therefore, according to Nyokabi et al. (2021), efforts to improve the access to safe water (6.1) also contribute to the delivery of ensuring safe and nutritious food (2.1).

S6b Maindi, Osuga and Gichecha (2020) found that ownership of a well had a positive effect on the number of climate-smart agricultural practices adopted. This study implies that the availability and accessibility of water can be a constraint to intensifying, coping and mitigating responses to climate change in dairy farming (Maindi et al., 2020). Therefore, attempts to deliver access to water (6.1) will in this context contribute to the delivery of resilient and sustainable agricultural practices (2.4).

S6c A synergy between targets 6.4 & 2.3 was identified. Rosinger et al. (2021) note that in Kenya it is necessary to implement appropriate land and water resource management as heat and scarce water hampers agriculture activity. They point out that ensuring water-use efficiency (6.4) will be likely to increase agricultural productivity, as the water footprint per unit of milk produced is improved (2.3).

S6d A synergy between targets 6.5 and 2.3 was identified. Warinda et al., (2020) describe that adoption of appropriate land and water resource management increase milk production from 6 to 11 litres per cow per day respectively. This study as well as the study by Rosinger et al. (2021) imply a synergy between the implementation of integrated water management practices (6.5) and increasing agricultural production (2.3).

T6a A trade-off was identified between target 2.1 and 6.1. The Kenyan population, especially the middle class, is expected to grow and therefore the demand for dairy products is expected to increase (Heller et al., 2020). To meet the demand for dairy products, the production will increase and this puts more pressure on water sources. Heller et al. (2020) as well as Bosire et al. (2019) expect efforts to ensure food security for the growing Kenyan population (2.1) impede the delivery ensuring equitable access to safe drinking water for all (6.1) as the demand for water increases.

T6b Bosire et al. (2017) found that the water used for increasing milk production near Nairobi is water which highly competes with other claims for water such as water to be consumed as drinking water. Therefore, increasing agricultural production (2.3) uses water which otherwise would be consumed as drinking water. Due to the water scarcity in Kenya, increasing agricultural production (2.3) thus hampers the delivery of ensuring safe drinking water for all (6.1).

S6e A synergy was found between target 2.4 with reducing water pollution (6.3). Carbonell (2021) points out that livestock production is a source of greenhouse gases and contributes to climate change and livestock production systems entail negative consequences on the environment such as land degradation

as well as air and water pollution. By adopting sustainable and resilient agricultural practices (2.4) incidences of water pollution are reduced and thus contribute to the delivery of target 6.3.

T6c Bosire et al. (2019) identified a trade-off between targets 2.3 and 6.4. The authors state that efforts to increase milk production demand high levels of water and thus put more pressure on water resources and thus increase water scarcity and hamper delivering target 6.4.

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG7: 'Affordable and clean energy'

S7a One synergy was identified between targets 7.1 and 2.1. Foster et al., (2015) describe that in commercial Kenyan dairy farming, the lack of energy access results in poor milk cooling and handling. This poor milk cooling and handing results in poor quality dairy products. Therefore, efforts to ensure access to energy (7.1) will be likely to have a positive effect on the delivery of safe and nutritious dairy products (2.1). Another study by Foster et al. (2015) reinforces this finding as they showed that providing solar energy milk cooling proves food security (7.1) and the provision of safe and nutritious food (2.1).

S7b One synergy was identified between SDG7 and target 2.3. Foster et al., (2017) and Foster et al., (2015) describe a synergy between ensuring access to energy (7.1) and improving the income of small-holder farmers (2.3). According to the authors, a lack of energy access results in insufficient milk cooling systems. For Kenyan dairy farmers, it was found that this poor milk cooling forces them to sell their milk cheaply before the milk spoils for lower prices (Foster et al., 2017; Foster et al., 2015). Therefore, ensuring access to energy (7.1) will result in improved milk cooling which allows farmers to store their milk longer and stops them from selling milk for low prices and thus improving small-holder farmer income (2.3).

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG8: 'Decent Work and Economic Growth'

S8a One synergy was identified between targets 8.2 and 2.3. Odadi, Riginos and Rubenstein (2018) investigated the adoption of tightly bunched herding on production outcomes. The authors found that adopting this innovation improved cattle performance and the financial benefit of improved cattle performance offsets the costs of the investment to implement tightly bunched herding. Therefore, in this case, there exists a synergy between achieving higher levels of economic productivity through the adoption of innovations (8.2) and achieving increased agricultural productivity and increased income for farmers (2.3).

S8b One synergy was found between target 8.3 & 2.3. In Kenya, young men and women lack access to land and capital to enter dairy production (Bullock and Crane, 2021). Youth-specific self-help groups which help overcome constrained access to land and capital as well as provide technical trainings (8.3) were found to contribute to improve agricultural production & secured equal access to land (2.3).

S8c A synergy was identified between targets 8.3 and 2.4. Kilelu, Van der Lee, Koge and Klerkx (2021) found that the transition to more sustainable and resilient agri-food systems requires increasing knowledge and entrepreneurial skills of farmers as technical and managerial improvements are needed to increase production. Efforts to increase skills regarding entrepreneurship and innovation amongst (8.3) current and future dairy farmers contribute to the delivery of delivering sustainable and resilient agricultural practices (2.4). Moreover, Bullock and Crane (2021) investigated the implementation of Youth-specific self-help groups. The authors found that the groups help overcome constrained access to land and capital as well as provide technical training. Participation of these groups leads to an increase in the adoption of sustainable agricultural practices. Therefore, this study reinforces the identified synergy Kilelu et al, (2021) between increasing skills regarding entrepreneurship and innovation (8.3) and were found to contribute to delivering more sustainable and resilient agriculture (2.4).

S8d One synergy was identified between targets 2.4 and 8.4. Herrero et al. (2014) explored how smallholder agricultural systems in Kenya might intensify and deliver more sustainable food production and resilient agricultural practices. The researchers found that improving global resource efficiency (8.4) in production results in more sustainable food production systems (2.4).

S8e Tavenner, Crane and Saxena (2021) analysed the practices of women's milk market practices and identified a synergy between ensuring equal pay for work of equal value (8.5) and the increase of income of female smallholder dairy farmers (2.3).

S8f A synergy was identified between targets 2.3 and 8.4. Bosire et al. (2019) investigated intensification pathways and their different use of land and water. The authors concluded that intensification of the dairy sector in some cases contributes to improved resource efficiency (8.4).

T8a A trade-off was identified between target 2.3 and 8.4. Bosire et al. (2019) investigated intensification pathways and their different use of land and water. The authors concluded that intensification of the dairy sector does not in all cases make the best use of water and land resources and they recommend a tailored approach that focuses on the optimal use of land and water in dairy production. Thus, achieving doubling agricultural productivity (2.3) by means of intensification of the dairy sector in some cases hampers delivering global resource efficiency (8.4).

S8g One synergy was identified between targets 2.4 and 8.4. Herrero et al. (2014) explored how smallholder agricultural systems in Kenya might intensify and deliver more sustainable food production and resilient agricultural practices. The researchers found that when more sustainable food production systems are in place (2.4) this contributes to the delivery of improving global resource efficiency (8.4).

T8b Debonne et al., (2021) describe a trade-off between target 2.3 and target 8.5. In case of an increase in farm size, fewer jobs per hectare are provided and thus results in less employment (Debonne et al., 2021).

They conclude that in the case of dairy intensification and increases in farm size (2.3) fewer jobs are available per hectare and thus negatively affect ensuring employment (8.5).

T8c Debonne et al., (2021) describe a trade-off between targets 2.3 and 8.6. In case of an increase in farm size, fewer jobs per hectare are provided and thus results in less employment. They conclude that in the case of dairy intensification and increases in farm size (2.3), fewer jobs are available per hectare and thus negatively affect ensuring employment for youth specifically (8.6).

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG9: 'Industry, Innovation and Infrastructure'

S9a A synergy was identified between targets 9.1 and 2.3. The study by Kiprono and Matsumoto (2018) indicates that improving roads (9.1) from farmers to nearby towns increases market access, nudges farmers to participate in the milk market and results in the improved income for smallholder farmers (2.3). This synergetic relationship is reinforced by Ogola and Kosgey (2019) and Van der Lee et al., (2020) who both found that improving roads reduces transportation costs and travel time resulting in increased market participation.

S9b A synergy between target 9.1 and 2.4 was found. Maindi, Osuga and Cichecha (2020) describe that access to markets determines the availability of inputs required for climate change adoption. Access to markets depends on the condition of infrastructure. Maindi, Osuga and Cichecha, (2020) found that improved road infrastructure resulted in an increase in the adoption of climate-smart agriculture practices. Therefore, improving road infrastructure (9.1) also contributes to the delivery of ensuring sustainable and resilient agricultural practices (2.4).

S9c A synergy was identified between targets 9.3 and 2.3. Warinda et al., (2020) investigated regional development programs for Kenyan farmers and found that improved infrastructure (9.3) in the form of access to finance, markets and innovations resulted in higher crop productivity and income (2.3).

S9d A synergy was identified between targets 9.3 and 2.4. Odhong et al. (2019) investigated the role of public climate finance on smallholder farmers in Kenya. The researchers found that the provision of climate finance through existing formal financial institutions would not be likely to impact a large number of dairy farmers, resulting from weak links between farmers and formal financing institutions and limited access to finance. The researchers bring forth capacity building as well as increasing access to finance (9.3) might overcome these disadvantages and might increase the adaptation of resilient and sustainable agricultural practices (2.4).

S10a Mwambi, Bijman and Galie (2021) found a synergy between target 10.2 and 2.3. The authors investigated the impact of membership in bargaining and processing producer organizations for women empowerment. The researchers found that empowering and promoting the inclusion of women (10.2) increases their access to agricultural resources resulting in increases in income for female dairy farmers (2.3).

S10b A synergy was found between target 2.3 with target 10.3. Tavener, Crane and Saxena (2021) analysed the spectrum of women's informal milk market practices in two regions where dairy system intensification is implemented. The researchers found that ensuring equal opportunities in dairy farming (10.3) will increase the income of female smallholder farmers (2.3).

S10c A synergy was found between targets 2.3 and 10.4. Tavener, Crane and Saxena (2021) analysed the spectrum of women's informal milk market practices in two regions where dairy system intensification is implemented. The researchers found that ensuring equal wage (10.4) will increase the income of female smallholder farmers (2.3).

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG12: 'Responsible consumption and production'

S12a. In Kenya, the demand for meat and milk is expected to increase and the production of these products will put more pressure on natural resources to meet all demands (Heller et al, 2020). The authors describe a synergy between targets 12.2 and 2.1. They note that efforts to deliver sustainable and efficient management of the use of natural resources (12.2) enable the delivery of ensuring food security (2.1).

S12b One synergy was identified between target 2.3 and SDG12. Bosire et al. (2019) investigated the water and land footprints of livestock production systems in Kenya. The authors conclude that the sustainable and efficient use of natural resources (12.2) enables agricultural productivity to double (2.3).

S12c According to Bosire et al. (2019) there is a two-way synergetic relationship between the sustainable and efficient use of natural resources (12.2) and ensuring sustainable and resilient agricultural practices (2.4). More sustainable and efficient use of natural resources in the context of dairy farming results in more sustainable and resilient agricultural practices.

S12d A synergy was found between targets 2.4 and 12.5. Replacing traditional livestock feed with insects is a means to reduce the environmental footprint of dairy production. Shumo et al. (2019)

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showed that feeding livestock with insects which live of waste streams (12.5) is successful in feeding livestock and simultaneously contributes to the delivery of more sustainable and resilient agricultural practices (2.4)

T12a A trade-off was identified between target 2.1 and 12.2. In Kenya, the demand for meat and milk is expected to increase and the production of these products will put more pressure on natural resources to meet all demands (Heller et al, 2020). According to the authors, attempts to achieve food security for all (2.1) might hamper achieving sustainable and efficient management of natural resources (12.2).

S12e According to Bosire et al. (2019) there is a two-way synergetic relationship between the sustainable and efficient use of natural resources (12.2) and ensuring sustainable and resilient agricultural practices (2.4). Sustainable and resilient agricultural practices include sustainable and efficient use of natural resources.

S12f A synergy was identified between targets 2.4 and 12.3. Kiambi et al. (2020) investigated challenges faced by stakeholders throughout the Nairobi dairy value chain. The study found that ensuring more sustainable practices (2.4) and improved milk handling and transportation will result in fewer losses due to spillage (12.3).

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG13: 'Climate action'

S13a One synergy was identified between target 2.1 and SDG13. Amongst pastoralists, livestock numbers are shown to decrease as a result of droughts (Boone and Lesorogol, 2016). The decrease in livestock numbers has a negative effect on milk production and farmer household well-being. This poses a risk to ensuring food security. According to Boone and Lesorogol (2016), efforts to strengthen resilience and adaptive capacity to climate-related hazards (13.1) contribute to the delivery of ensuring food security (2.1) amongst pastoralists. This synergetic relationship is reinforced by the study by Joutsjoki and Korhonen (2021) and Quandt and Kimathi (2017) who both emphasize the need of resilience and adaptive capacity to climate-related hazards to ensure food security.

S13b A synergy was identified between targets 13.1 and 2.3. For dairy farmers, becoming more resilient against climate change by adopting other feed crops which are not much impacted by climate change effects results in increased productivity (Maina et al., 2020). Therefore, this study implies a synergetic relationship between adopting strategies to strengthen resilience and adaptive capacity to climate-related hazards (13.1) with delivering a doubling of agricultural productivity (2.3). This finding is reinforced by the study by Boone and Lesorogol (2016). They conclude that efforts to strengthen

resilience and adaptive capacity to climate-related hazards (13.1) contribute to the delivery of ensuring food security amongst pastoralists, as well as secure their income from agriculture (2.3).

S13c Kitonga et al. (2020), Leparmarai et al. (2021), Volenzo, Makungo & Ekosse (2021) and Quandt & Kimathi (2017) all describe a synergetic relationship between strengthening resilience and adaptive capacity to climate-related hazards and natural disasters (13.1) with delivering sustainable and resilient agricultural practices (2.4).

T13a A trade-off exists between targets 13.2 and 2.3. Volenzo, Makungo and Ekosse (2021) investigated the effects of institutional constraints on the effectiveness of climate action amongst small-scale dairy farmers. The authors describe that in some cases practices to deliver climate action (13.2) undermine productivity and income (2.3), and thus negatively impact the delivery of target 2.3.

S13d A synergy was identified between targets 2.4 and 13.2. Implementing climate change measures speeds up the process to deliver sustainable agriculture (Brandt, Herold and Rufino, 2018). Therefore, a synergetic relationship exists between implementing climate change measures (13.2) and delivering sustainable and resilient agricultural practices (2.4).

S13e A synergy was identified between targets 13.3 and 2.4. Maindi, Osuga, Gicheha (2020) find that exposure of farmers to climate information increases the knowledge and awareness of climate change (13.3) and therefore results in an increase in the adoption of climate-smart agricultural practices. Thus efforts to realise target 13.3, simultaneously contribute to the delivery of more resilient and sustainable agricultural practices (2.4).

S13f A two-way synergetic relationship was identified between target 2.4 and 13.1. Kitonga et al. (2020), Leparmarai et al. (2021), Volenzo, Makungo & Ekosse (2021) and Quandt & Kimathi (2017) all describe a synergetic relationship between delivering sustainable and resilient agricultural practices (2.4) and efforts to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters (13.1).

Elaboration on interactions between SDG2: 'Zero Hunger' and SDG15: 'Life on Land'

S15a Bosire et al. (2016) found a synergetic relationship between the conservation of ecosystems (15.1) and achieving food security for all (2.1) as conserving ecosystems enables sufficient production to provide food for all.

S15b A synergy was identified between targets 15.3 and 2.1. Brandt et al. (2020), Mureithi et al. (2016), Odadi, Fargione & Rubenstein (2017) and Bosire et al. (2016) all have identified a synergy

between conserving land and combating desertification (15.3) with achieving food security (2.1) as conservation of land is needed to be able to produce food items. Mureithi et al. (2016) emphasize that the improved quality of land and soil due to restoration results in improved food security for the farmer households.

S15c Maisiaine et al. (2021) identified a synergy between targets 15.3 and 2.3. The authors conclude that efforts to combat degradation help to increase productivity because in that case there is more land for grazing available and fewer conflicts between livestock and wildlife. Mulinge et al. (2015) also reinforce this by concluding that land degradation had a negative impact on milk yields thus efforts to combat land degradation (15.3) will have co-benefits on agricultural production and income for small scale farmers (2.3). Moreover, Mureithi et al. (2018) reinforce this synergy as they identified additional benefits in the case of rangeland rehabilitation. The authors found that rehabilitation of rangelands (15.3), soil quality and thereby the potential for agricultural productivity increased (2.3).

S15d Ensuring the restoration and conservation of forests (15.2) is found to have a synergetic relationship with implementing sustainable and productive livestock production (2.4), as these forests are utilized as a source of fodder for livestock (Kitonga et al., 2020). Therefore, there exists a two-way synergetic relationship between delivering sustainable and resilient agricultural practices (2.4) and halting deforestation (15.2).

S15e a synergetic relationship is identified between integrating ecosystem values into national and local planning, development processes and poverty reduction (15.9) with ensuring an increase in income of smallholder farmers (2.3) (Bosire et al., 2016). Brandt et al., (2020) reinforce this synergy and emphasise the importance of local planning as they found that top-down assessments may render the effectiveness of the policies.

T15a A trade-off and synergy were identified between target 2.1 and 15.1 Bird, Zanchi & Pena (2013) and Maindi, Osuga & Gicheha (2020) both state in their articles that there is a trade-off between delivering food security (2.1) and ensuring the conservation of ecosystems (15.1) in case dairy products are used to feed everyone (2.1). According to the researchers, dairy products are unsustainable and put more pressure on land and forests.

S15f Bird, Zanchi & Pena (2013) imply that increasing agricultural productivity (2.3) has a synergetic relationship with ensuring the conservation of ecosystems (15.1),

T15b Bosire et al. (2019) and Carbonell et al. (2021) note that doubling agricultural productivity (2.3) by means of dairy intensification hampers the delivery of conservation of the ecosystem (15.1) as

intensification pollutes water and air and contributes to land degradation and emissions. Bosire et al. (2016) indicate that it is possible to increase production (2.3) to meet increasing demands for meat and milk through intensification while also conserving ecosystems (15.1) and land (15.3). The authors note that the success is dependent on the enabling policies, arrangements and markets and on ensuring that relevant information is available to farmers.

S15g It was found that implementing sustainable agricultural practices (2.4) enabled Kenyan dairy farmers to contribute to the restoration of land and improve the quality of land and soil (15.3) (Bosire et al., 2019; Bosire et al., 2017; Keesing et al., 2013; Brandt et al., 2020; Carbonell et al., 2021; Maindi, Osuga & Gicheha, 2020; Odadi, Fargione & Rubenstein 2017). Therefore, a synergy between implementing resilient and sustainable agricultural practices (2.4) and the conservation of freshwater ecosystems and their services (15.1).

S15h thirdly, a synergy and trade-off were identified between targets 2.3 and 15.2. Brandt et al. (2020) describe that currently, deforestation occurs due to realizing agricultural expansion. By increasing agricultural productivity, less expansion is needed and therefore doubling agricultural productivity (2.3) contributes to the delivery of combating deforestation (15.2).

T15c On the other hand, Carbonell et al. (2021) note that doubling agricultural productivity by means of dairy intensification (2.3) hampers the delivery of halting deforestation (15.2).

S15i Brandt et al. (2020) state agriculture is the main cause of deforestation in Sub Saharan Africa. Replacing agricultural practices which cause deforestation with sustainable and resilient agricultural practices thereby contributes to target 15.2, halting deforestation. Additionally, the authors note that the presence of forests is important to agriculture as its absence causes negative feedback on agricultural production such as affected water and nutrient cycling and a loss of biodiversity.

S15j Bird, Zanchi & Pena (2013) imply that increasing agricultural productivity (2.3) has a synergetic relationship with the delivery of combating land degradation (15.3)

T15d Bosire et al. (2019) and Carbonell et al. (2021) note that doubling agricultural productivity (2.3) by means of dairy intensification hampers the delivery of combating land degradation (15.3) as intensification pollutes water and air and contributes to land degradation and emissions. NOTE Bosire et al. (2016) indicate that it is possible to increase production (2.3) to meet increasing demands for meat and milk through intensification while also conserving ecosystems (15.1) and land (15.3). The authors note that the success is dependent on the enabling policies, arrangements and markets and on ensuring that relevant information is available to farmers.

S15k It was found that implementing sustainable agricultural practices (2.4) enabled Kenyan dairy farmers to contribute to the restoration of land and improve the quality of land and soil (15.3) (Bosire et al., 2019; Bosire et al., 2017; Keesing et al., 2013; Brandt et al., 2020; Carbonell et al., 2021; Maindi, Osuga & Gicheha, 2020; Odadi, Fargione & Rubenstein 2017). Therefore, a synergy between implementing resilient and sustainable agricultural practices (2.4) and delivering restoration of land and soil (15.3) exists.

S15l Bird, Zanchi & Pena (2013) imply that increasing agricultural productivity (2.3) has a synergetic relationship with the delivery of combating degradation of natural habitats (15.5).

S15m On Kenyan rangelands, cattle, in some cases, compete with wildlife for forage. In order to reduce the biodiversity loss and degradation of natural habitats, sustainable livestock management is needed. Therefore, by adopting sustainable livestock grazing as a strategy to deliver sustainable and resilient agricultural practices (2.4), simultaneously natural habitats of wildlife on Kenyan rangelands and biodiversity will be conserved (15.5) (Keesing et al., 2013). This is reinforced by other studies (Bosire et al., 2019; Bosire et al., 2017; Keesing et al., 2013; Brandt et al., 2020; Carbonell et al., 2021; Maindi, Osuga & Gicheha, 2020; Odadi, Fargione & Rubenstein 2017). The studies describe a synergy between implementing resilient and sustainable agricultural practices (2.4) and ending land degradation (15.5). The findings of Maindi, Osuga & Gicheha, (2020) specifically stress that it is a necessity to implement sustainable and resilient agricultural practices in order to mitigate the degradation of resources while enhancing farmers' income and food security. Proposed practices to accomplish this are implementing holistic grazing management (Odadi, Fargione & Rubenstein, 2021) or adopting agroforestry (Kitonga et al., 2020).

Appendix V: Tables providing an overview of the nature of interactions between SDG2 and other SDGs at target level and by directionality.

Tables 34 provide an overview of interactions, categorised by direction (incoming, outgoing) and the nature of the interactions (synergy and trade-offs).

Table 34: Overview of interactions, categorised by direction (incoming, outgoing) and the nature of the interactions (synergy and trade-offs)

	Incoming		Outgoing		
	Synergy	Trade-offs	Synergy	Trade-off	Total
SDG1	2	1	3	0	6
SDG3	0	0	5	0	5
SDG4	7	1	2	0	10
SDG5	4	0	0	2	6
SDG6	4	0	1	3	8
SDG7	2	0	0	0	2
SDG8	5	0	2	3	10
SDG9	4	0	0	0	4
SDG10	3	0	0	0	3
SDG11	0	0	0	0	0
SDG12	4	0	2	1	7
SDG13	5	1	1	0	7
SDG14	0	0	0	0	0
SDG15	5	0	8	4	17
Total	45	3	24	13	85

Tables 35-38 provide an overview of the directionality (incoming or outgoing) and nature (synergy or trade-off) for every target of SDG2, expect for target 2.5 as no interactions were identified regarding target 2.5.

Table 35: Overview of interactions regarding target 2.1 with targets of other SDGs, distinguished by incoming or outgoing and synergy or trade-off

TARGET 2. 1	Incoming		Outgoing		
	Synergy	Trade-offs	Synergy	Trade-off	Total
SDG1	2	0	0	0	2
SDG3	0	0	2	0	2
SDG4	2	0	0	0	2
SDG5	1	0	0	0	1
SDG6	1	0	0	1	2
SDG7	1	0	0	0	1
SDG8	0	0	0	0	0
SDG9	0	0	0	0	0
SDG10	0	0	0	0	0
SDG11	0	0	0	0	0
SDG12	1	0	0	1	2
SDG13	1	0	0	0	1
SDG14	0	0	0	0	0
SDG15	2	0	0	1	3
Total	11	0	2	3	16

Table 36: Overview of interactions regarding target 2.2 with targets of other SDGs, distinguished by incoming or outgoing and synergy or trade-off

TARGET 2. 2	Incoming		Outgoing		
	Synergy	Trade-offs	Synergy	Trade-off	Total
SDG1	0	1	0	0	1
SDG3	0	0	1	0	1
SDG4	2	0	1	0	3
SDG5	0	0	0	0	0
SDG6	0	0	0	0	0
SDG7	0	0	0	0	0
SDG8	0	0	0	0	0
SDG9	0	0	0	0	0
SDG10	0	0	0	0	0
SDG11	0	0	0	0	0
SDG12	0	0	0	0	0
SDG13	0	0	0	0	0
SDG14	0	0	0	0	0
SDG15	0	0	0	0	0
Total	2	1	2	0	5

Table 37: Overview of interactions regarding target 2.3 with targets of other SDGs, distinguished by incoming or outgoing and synergy or trade-off

TARGET 2.3	Incoming		Outgoing		
	Synergy	Trade-offs	Synergy	Trade-off	Total
SDG1	0	0	1	0	1
SDG3	0	0	1	0	1
SDG4	2	1	1	0	4
SDG5	2	0	0	2	4
SDG6	2	0	0	2	4
SDG7	1	0	0	0	1
SDG8	3	0	1	3	7
SDG9	2	0	0	0	2
SDG10	3	0	0	0	3
SDG11	0	0	0	0	0
SDG12	1	0	0	0	1
SDG13	1	1	0	0	2
SDG14	0	0	0	0	0
SDG15	2	0	4	3	9
Total	19	2	8	10	39

Table 38: Overview of interactions regarding target 2.4 with targets of other SDGs, distinguished by incoming or outgoing and synergy or trade-off

TARGET 2. 4	Incoming		Outgoing		
	Synergy	Trade-offs	Synergy	Trade-off	Total
SDG1	0	0	2	0	2
SDG3	0	0	1	0	1
SDG4	1	0	0	0	1
SDG5	1	0	0	0	1
SDG6	1	0	1	0	2
SDG7	0	0	0	0	0
SDG8	2	0	1	0	3
SDG9	2	0	0	0	2
SDG10	0	0	0	0	0
SDG11	0	0	0	0	0
SDG12	2	0	2	0	4
SDG13	3	0	1	0	4
SDG14	0	0	0	0	0
SDG15	1	0	4	0	5
Total	13	0	12	0	25