

## **Thesis Report**

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# **When is data governance in data-driven smallholder agriculture fair?**

Developing a framework for sustainable data governance in smallholder farming

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A handwritten signature in black ink, appearing to read 'N. Beranek', with a stylized flourish at the end.

## Abstract

Smallholder farmers are vulnerable because they lack access to essential infrastructures, information, and financial resources. The dissemination of digital tools through data-driven applications is expected to transform the livelihoods of smallholders by significantly reducing poverty and inequality. Nevertheless, there is no consensus on general principles that should govern this transformation process and ensure that it is fair and in line with the Sustainable Development Goals. Therefore, this thesis proposes a set of five principles for smallholder-oriented data governance in data-driven smallholder agriculture and ten enabling conditions that stakeholders of the smallholder data ecosystem could use to assess their data governance practices.

This thesis project was conducted within the scope of Maastricht University Fair and Smart Data Spearhead project. It is an exploratory study employing qualitative research methodologies such as document analysis and stakeholder feedback to develop a principle-based framework. This thesis report discusses the challenges in data-driven smallholder agriculture. It concludes that a combination of private and public-sector-led initiatives is necessary to facilitate the adoption of the proposed principles in practice and to balance equitable relationships despite resource asymmetries among stakeholders of the smallholder data ecosystem.

Keywords: Sustainability, Smallholder Agriculture, Data Governance, Digital Sovereignty, Fairness.

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## III. Abbreviations

<b>Abbreviation</b>	<b>Denotation</b>
FAO	Food and Agriculture Organization of the United Nations
FSD	Fair and Smart Data Spearhead project
ICT	Information and Communication Technology
NGO	Non-governmental Organization
SDE	Smallholder data ecosystem
SDG	Sustainable Development Goal
WFP	World Food Programme

## 1. Overview and orientation

### 1.1 Thesis statement

The research for this thesis was conducted within the scope of the Fair and Smart Data Spearhead project (FSD), which, among other things, aims to create a set of criteria to evaluate data-driven business models and projects targeting smallholder farmers. By introducing standards for sustainable value networks, the FSD research project intends to expand the knowledge base on how Sustainable Development can be implemented in the agri-food sector of the Global South (FSD, 2022a). Smallholder farming is the predominant form of agricultural production in low-income countries, particularly in Asia and Africa (OECD & FAO, 2020). However, smallholders are disadvantaged in the respective value chains and often receive the lowest value for their products (Ferris & Rahman, 2016; FSD, 2022a). Data-driven technologies in agriculture promise to improve Sustainable Development by improving the livelihoods of smallholders, their families and communities as well as environmental protection by making farming practices more efficient and allowing smallholders to access valuable information (Maru et al., 2018). The FSD, therefore, aims to investigate the risks and benefits of data-driven technologies for smallholders and their impact on the fairness of global value chains and Sustainable Development (FSD, 2022a).

### 1.2 Outline

The following introduction, '*Sustainable Development challenges in smallholder farming*,' will establish the relevant background and rationale of this thesis by introducing some Sustainable Development challenges faced by smallholders. The following extended literature review introduces some essential concepts and approaches related to the research questions explored in this thesis. Then the chapter '*research design*' introduces the methodological approach taken and explains how it helps to answer the research questions and fulfill the aims of this thesis project. Next, the chapter '*A theoretical model of smallholder-oriented data governance in data-driven smallholder agriculture*' builds on the groundwork established in the previous sections and synthesizes relevant concepts to answer the main research question. Finally, the result is discussed in the following chapter, '*Discussion and recommendation*', followed by a conclusion.

### 1.3 Sustainable Development challenges in smallholder farming

The Sustainable Development Goals (SDGs) aim to transform societies worldwide towards a more sustainable future by addressing global environmental challenges, inequality, or poverty, particularly for disadvantaged or vulnerable people (Quayson et al., 2021; United Nations, 2015). However, today's global supply chains contribute to environmental, social, and economic unsustainability by supporting farming practices damaging natural ecosystems, low commodity prices, and the exclusion of smallholders from access to information and financial resources (Quayson et al., 2021). Quayson et al. (2021 p.1) point out, "(...) the African agriculture commodity supply chain—beginning with its smallholder farmers—are at the mercy of various influential actors from established global supply chains", such as the four dominant stakeholders in the global food industry (ADM, Bunge, Cargill, and Louis-Dreyfus), among others. Nevertheless, the same stakeholders in global value chains could also contribute significantly to improving the living conditions of vulnerable or disadvantaged people in communities in the Global South<sup>1</sup> (Quayson et al., 2021).

Smallholders produce essential commodities such as cocoa, coffee, rice, tea, maize, or sugar, which pass through many intermediary stakeholders in the agricultural value chain before they get to the final consumers. In many cases, consumers of the mentioned commodities are located in the Global North, including The Netherlands, Germany, and other high-income countries (Quayson et al., 2021). However, "along this complex supply chain, smallholder farmers face fraud, exploitation, corruption, deceit, and child and slave labor" (Quayson et al., 2021 p.2).

Furthermore, after decades of global efforts to eliminate hunger, progress is stalling due to climate change, conflict, and the Covid-19 pandemic (FAO, 2021; The Economist, 2022). As a result, according to the World Food Programme (WFP), the number of people who are severely food-insecure (meaning that they are so short of food that their lives or their livelihoods are at risk) more than doubled from 135 million to 345 million since 2019 (The Economist, 2022; WFP, 2022). Reversing this trend requires global collective action and vigorous policy making.

Over the past ten years, the number of smallholders using digital tools has grown significantly, contributing to the transformation of the agricultural sector globally (Maru et al., 2018). On the African continent alone, more than 33 million smallholder farmers are already involved in data-

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<sup>1</sup> The distinction of countries in the Global North (GN) and Global South (GS) is based on Schafer et al. (2017), which suggests an income-based categorization of countries with different developed economies compared to a geographical definition. From this follow, those high-income countries such as in Europe and North America can be found in the GN, whereas low-income counties are primarily found on the African continent and South-West Asia.

driven<sup>2</sup> smallholder agriculture. This trend is expected to continue and exceed 200 million smallholders by 2030 (SNRD, 2022; Tsan et al., 2019). But as of now, there is no consensus on benchmarks vis-à-vis the sustainability<sup>3</sup> of such developments, particularly which attributes a data-governance arrangement should have to ensure the fair treatment and inclusion of smallholders engaging in data-driven activities. Hence, smallholders, companies, and projects involved in data-driven smallholder agriculture have no shared means of assessing the quality in terms of fairness and sustainability of the data governance arrangement in place. This situation bears the risk of “(...) a potential “Wild West” of data governance, from which only the most powerful actors and monopolies will be in a position to benefit” (GFAR, 2018 p.3). Furthermore, without investing in well-informed policy making, there is the risk that the digitalization in smallholder agriculture will be fragmented, neither sustainable nor inclusive or fair (Hailu, 2019). Therefore, to capitalize on the opportunities data-driven tools and business models provide for social, environmental, and economic sustainability in smallholder farming, this thesis explores the question ‘which attributes make for smallholder-oriented data governance in data-driven smallholder agriculture?’

This thesis report synthesizes the conducted research to propose a set of principles and enabling conditions that could guide and benefit all stakeholders in global agricultural value chains towards developing fair data governance policies regarding sustainability, inclusivity, and digital sovereignty.

## **1.4 Literature review**

The following chapter summarizes the results of a systematic literature review conducted for this thesis research project. It focuses on the essential topics identified as most relevant regarding the aims of this thesis. First, the notion of 'smallholder farmer' is conceptualized to arrive at a working definition. The following section addresses the growing relevancy of data governance in the context of Sustainable Development and introduces potential use cases for data in smallholder agriculture. Furthermore, this literature review outlines the structure and allocation of roles between stakeholders of the smallholder data ecosystem. Finally, the notion of fairness is essential for this thesis which was conceptualized in the final section of this literature review along with challenges vis-à-vis fair data governance in smallholder farming.

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<sup>2</sup> Data-driven (data) refers to data that is produced, shared, and processed by using mobile electronic technologies (ICT applications). In the context of this thesis, such technologies are intended to help smallholder farmers to get access to a basic data infrastructure supporting smallholders in accessing agricultural inputs, markets, finances, or extension services.

<sup>3</sup> Sustainability in this context intends to indicate the relationship between long-term (social, environmental, economic) developments of the living situation of smallholder farmers in the Global South and the lack of qualitative (normative) assessment regarding the use of digital applications to improve the livelihoods of smallholders in the scope of the triple bottom line.

#### 1.4.1 Who is a smallholder farmer?

To explain what constitutes 'fair' or 'smallholder-oriented' data governance, the notion of 'smallholder farmer' must be conceptualized. However, defining what constitutes a smallholder farmer is challenging since farmers or particularly smallholder farmers are not a homogeneous group (Gray et al., 2018). To date, there is no universally accepted definition of what constitutes a smallholder farmer since there is also no clarity by which criteria such a qualification should be undertaken (Anderson et al., 2016; CFS, 2015). Therefore, this section reviews existing attempts to define what is smallholder farming before outlining the working definition of 'smallholder farmer' in this thesis.

Farms are frequently classified as 'small' when the size of the farmed land is smaller than two hectares (CFS, 2015; FAO, 2022; Lowder et al., 2016; World Bank, 2017). Although farm size can vary significantly by country and region, small farms operate most of the farmed land in the Global South and supply more than 70 percent of the overall food production (CFS, 2015). Smallholders, therefore, are essential to the agricultural sector in many countries of the Global South.

Although farm size is the most frequently used criterion to describe smallholder farming, smallholder farming is characterized by many additional conditions that are more expressive (Anderson et al., 2016; Gray et al., 2018; Lowder et al., 2016). This is because the average farm sizes of smallholders can vary significantly depending on the respective country, from 0.9 hectares in Tanzania to 46 hectares in Malaysia (Anderson et al., 2016).

However, the FAO (2022) describes a set of characteristics of smallholder farmers in terms of:

- Housing and sanitation conditions
- Share of national food production
- Per hectare productivity
- Time spent working on the farm
- Access to innovation and credit
- The level of mechanization
- The share of produce sold compared to the amount produced
- The share of income generated in other sectors than farming
- The level of poverty (share of income spent to buy or produce food is more than 50 percent)

For example, 74 percent of smallholders in Kenya live in houses with dirt floors. In Nepal, 78 percent of smallholders have access to safe drinking water and sanitation facilities, but only 31 percent have access to electricity (FAO, 2022; World Bank, 2017). Furthermore, the role of smallholders in food production can be immense. For instance, according to the FAO (2022), 70 percent of food produced in Nepal and 85 percent in Bolivia is produced by smallholder farmers. Moreover, smallholders spend more time working on their farms than farmers cultivating larger fields. In Kenya and Nepal, two to five family members work in one hectare daily. This work can result in a higher per hectare productivity than other farmers (FAO, 2022). However, the FAO (2022) also states that the productivity advantage weakens over time due to difficulties in adopting more efficient farming practices and the emergence of supermarkets constraining access for smallholders to sell their produce. Another characteristic of smallholders is their limited access to improved technologies that provide higher-yielding crop varieties and financial services such as credits.

Furthermore, the level of mechanization varies depending on the country but remains low. For example, while in Bangladesh, more than half of smallholders use motor-powered farming gear, only four percent of them are doing so in Ethiopia. According to the FAO (2022), an additional characteristic of smallholders is that most crops produced by smallholders are consumed in the same household. In Kenya and Ethiopia, e.g., smallholders sell less than 25 percent of their produce (FAO, 2022). Therefore, smallholders are also subsistence farmers to a large extent (Fan et al., 2013). Another reason for smallholders to be active in the agricultural sector is market-oriented, e.g., when they engage in commodity farming such as cocoa, tea, coffee, or palm oil. Nevertheless, most smallholders worldwide and across agricultural value chains do not earn a living income despite numerous private and public sector initiatives (Farmer Income Lab, 2022; The Living Income, 2021; Waarts et al., 2019). Hence, a final characteristic of smallholders, according to the FAO (2022), is the prevailing poverty level. In many countries, poverty levels among smallholders are significantly higher than the national average of people living in poverty. In Bolivia, e.g., the national poverty average is around 61 percent, while 83 percent of Bolivian smallholders are considered poor. Poverty often forces smallholders to work in other sectors than agriculture to generate income. However, the jobs are generally low-salary activities due to low levels of education and a lack of financial resources or access to information. Furthermore, poverty forces smallholders to spend more than 50 percent of their income to buy or produce food themselves (Anderson et al., 2016; FAO, 2022). For example, an average smallholder family of five persons in Tanzania lives on 1.9 US Dollars per day and spends 81 percent of this budget on food (FAO, 2022; Waarts et al., 2019).

Desk research uncovered that while the described socio-economic conditions can vary from country to country, they are generally descriptive of smallholder farmers (Anderson et al., 2016; FAO, 2022; Gray et al., 2018; Lowder et al., 2016). However, a more specific approach to defining smallholder farmers is proposed by Anderson et al. (2016). The authors suggest nine key criteria and respective considerations which partly overlap with the living conditions of smallholders described by the FAO (2022).

Table 1. Key criteria in defining smallholders. Adapted from Anderson et al. (2016).

<b>Key criteria</b>	<b>Considerations</b>
Market orientation	Subsistence vs. market-oriented vs. hybrid
Landholding size	Threshold
Labor input	Family vs. hired
Income	Shared income from farming, multiple sources
Farming system	Technology
Farm management responsibility	Owner, influence over how to farm
Capacity	Storage, management, administration
Legal aspects	Formal vs. informal
Level of organization	Member of a group of producers, supply chain

Compared to the smallholder portrait by the FAO (2022), Anderson et al. (2016) suggest considering four additional criteria (additional to the market orientation, landholding size, labor input, income, and farming system discussed before). First is the level of influence a smallholder has when working on a farm. This can vary significantly between ownership and slave labor (Anderson et al., 2016; Kalita et al., 2012; Quayson et al., 2021). Second, the capacity of smallholders to store their produce or deal with the administration is generally low, which can lead to losing food or capital (Anderson et al., 2016; Miller et al., 2013). Third, legal aspects, e.g., land rights, are often informal in smallholder farming. Fourth, in some cases, farmland ownership is unclear (Anderson et al., 2016). The fourth complementary criterion suggested by Anderson et al. (2016) is the level of organization. According to the authors, whether a farmer is a member of a group of producers and their respective position in the supply chain should also be considered.

Based on the literature review, the different approaches to defining who qualifies as a smallholder farmer were coded and synthesized into six fundamental criteria relevant to smallholder farming, which inform the working definition for this thesis.

Table 2. The working definition of smallholder farmers.

<b>Smallholder farmers are:</b>	<b>Essential criteria</b>
Located in rural areas of low-income countries	Geographic
a vulnerable community	Social
limited in financial resources	Economic
mostly subsistence farming	Reason of farming
usually cultivating smaller fields	Farm size
limited in their access to essential infrastructures	Access to infrastructure, including education

Based on the literature review, smallholders are a vulnerable group of people, mostly living in rural areas of low-income countries with limited access to financial resources and essential infrastructures. Furthermore, many smallholders cultivate small fields to feed their families.

To complete the definition used in this thesis, it should further be noted that this thesis focuses on smallholders that engage in data-driven agriculture. Gray et al. (2018 p.1) define data-driven agriculture as the “thoughtful use of data (...) to inform farmer decisions and actions. It means having the right data, at the right time, to make better decisions that improve long-term profitability”.

#### 1.4.2 Data governance for Sustainable Development

Data has become the world’s most valuable resource (The Economist, 2017). In 2022, the four most valuable companies in terms of market capitalization, Apple, Amazon, Google, and Microsoft, have a combined value of more than 1.1 trillion U.S. Dollars (Statista, 2022). As the relevance of data as a tradable resource grows in the global economy across sectors and value chains, its relevancy also grows in the context of Sustainable Development and smallholder farming (Gillwald et al., 2018; Maru et al., 2018; Mehrabi et al., 2021; Miller et al., 2013; USAID, 2018). Today, data-driven agriculture is adopted by 33 million smallholders in Africa and is expected to reach 200 million by 2030, which accounts for 80 percent of smallholders on the African continent (Tsan et al., 2019). Moreover, improved access to Information and Communication Technologies (ICTs)<sup>4</sup> infrastructure is expected to accelerate the spread of digital tools and business models in the agricultural sector (World Bank, 2017). For example, Tsan et al. (2019) expect most smallholders will have a mobile phone by 2025, meaning that by 2030, 200

<sup>4</sup> Information and communications technology (ICT) are digital technologies such as mobile phones that entail improving access to reliable and timely information (Miller et al., 2013).

million smallholders could profit from digitalization if the technology and the data it generates are governed equitably.

The following chapter introduces the concept of data governance and explains its relevance to Sustainable Development. First, data-driven smallholder agriculture must be conceptualized to understand the growing relevance of data governance to Sustainable Development.

Public and private sector entities have long tried to find effective solutions to address the challenges in smallholder agriculture, including the need to access relevant information. According to the World Bank (2017), ICTs constitute one solution with the potential to improve agricultural practices, especially in countries of the Global South, because it enables access to valuable information for smallholder farmers.

According to Ferris and Rahman (2016), the most valuable information to growers includes data on weather, soil and land, property ownership, and markets. However, using data-driven applications in smallholder agriculture has various benefits for Sustainable Development (Waruingi & Muriithi, 2016). Furthermore, achieving the Sustainable Development Goals (SDGs) set in the Agenda 2030 requires collective action on environmental, social, and economic challenges (United Nations, 2015). Hence, the availability and accessibility of high-quality data are prerequisites for reliable decision-making and accountability of stakeholders. However, data governance should be organized in a participatory and inclusive way to make the data and information accessible to all stakeholders in Sustainable Development, such as smallholders, businesses, and governments (United Nations, 2014).

The concept of governance incorporates various interpretations depending on the context where it is used (Jordan, 2008; Stoker, 1998). However, in the context of Sustainable Development and this thesis, respectively, governance denotes the process of governing beyond government. "(...) government is understood to refer to the formal and institutional processes which operate at the level of the nation-state to maintain public order and facilitate collective action (Stoker, 1998 p.1). Furthermore, governance is concerned with creating conditions in which organized collective action is possible among public and private actors and individuals. A central characteristic of governance systems, therefore, is that rules that govern the systems cannot be imposed but instead result from interactions by each other influencing stakeholders (Stoker, 1998). Gasser and Almeida (2022) describe the governance associated with digital technology as digital governance. The terms digital and data governance are used interchangeably in this thesis because both describe the process of governing the exchange of digital information among

stakeholders as part of the data economy (Cohen & Wendehorst, 2022). Digital governance in the scope of data-driven smallholder agriculture can therefore be seen as a societal effort to design new forms of governance to deal with the risks associated with the use of digital technology and its essential resource: data (Gasser & Almeida, 2022).

The concept of Sustainable Development is formed mainly by definitions popularized by the Brundtland Report titled *Our Common Future* (Jordan, 2008; WCED, 1987). The report aimed to steer the common narrative of trade-offs between the three pillars of Sustainable Development (people, planet, economy) toward possible synergies. It did that by prominently defining Sustainable Development as "(...) development that meets the needs of the present without comprising the ability of future generations to meet their own needs" (WCED, 1987 p.43). On the one hand, such a broad definition potentially risks ambiguous interpretation and, consequently, irrelevance. However, on the other hand, a more precise definition makes consensus more unlikely, especially in the case of the challenges faced in Sustainable Development that are characterized by uncertainty in knowledge and clashing stakeholders' values (Hoppe, 2010; Jordan, 2008). Instead, Jordan (2008) points out that there is substantial value in questioning and examining the meaning of Sustainable Development in particular decision-making contexts and that this loose definition is, therefore, an essential characteristic of Sustainable Development. Since the Brundtland Report was published in 1987, the constant struggle for defining and interpreting Sustainable Development resulted in connotations or general principles of Sustainable Development such as: "(...) improving intergenerational and intragenerational equity; alleviating chronic poverty; encouraging public participation in decision making; observing important environmental limits to growth; and integrating an environmental dimension into all sectoral policy-making" (Jordan, 2008 p.20). These principles of Sustainable Development were successively developed and extended in various internationally recognized documents such as the Rio Declaration (United Nations, 1992b, 1992a) and the report of the World Summit on Sustainable Development (United Nations, 2002). Finally, they resulted in the Agenda 2030 with its 17 Sustainable Development Goals (SDGs) (United Nations, 2015).

As some authors point out, data governance could help to address some of the significant sustainability challenges around various SDGs (Addison, 2018; Bakker et al., 2018; Carolan et al., 2015; Solidaridad, 2022; The Living Income, 2021; United Nations, 2014). The following figure illustrates potential use cases for data in data-driven smallholder agriculture and shows how smallholder data can be used to improve Sustainable Development.

Figure 1: Potential use cases for 'Fair' farm data. Adopted from Solidaridad (2022).

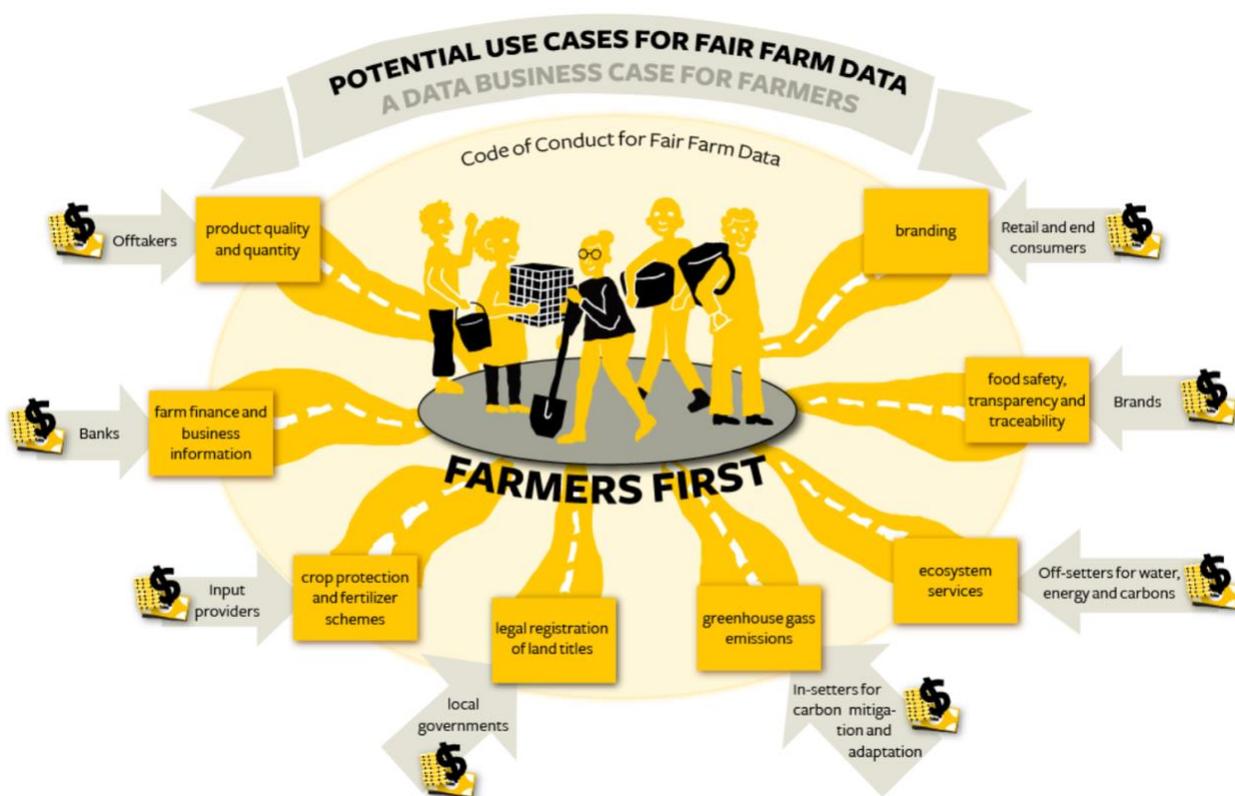


Figure 1 illustrates potential business cases of how data could contribute to Sustainable Development in smallholder farming under the condition that the data is harnessed and governed in a 'fair' way. The gray arrows indicate different stakeholders along the smallholder data value chain with various interests in using smallholders' data. Banks, e.g., could use smallholders' data to develop financial products that help farmers to access loans or micro-insurance, which could improve their economic situation significantly (Solidaridad, 2022; Waruingi & Muriithi, 2016). Another example illustrated in Figure 1 is the potential of smallholder data to improve ecosystem services, e.g., when stakeholders cooperate with smallholders to offset their carbon emissions (Rabobank, 2022; Solidaridad, 2022).

### 1.4.3 The smallholder data ecosystem

Developing a framework for fair data governance in data-driven smallholder agriculture requires understanding the system's structure and through which roles, functions, and interactions its stakeholders are characterized. Understanding this can help the stakeholders to acknowledge the relevance of fair data governance principles (M. Nkomo, personal communication, August 4, 2022). Furthermore, clarity about how a governance system is structured can help to identify possible ways stakeholders could manipulate a system to their benefit, which would be at the expense of Sustainable Development in the case of the smallholder data ecosystem (SDE) (McDonald, 2021). Therefore, the following chapter clarifies the different roles occupied by stakeholders of the SDE and their respective functions regarding fair data governance.

The SDE is embedded in the global data economy<sup>5</sup> and can therefore be characterized as a subsystem of it (Cohen & Wendehorst, 2022; Tsan et al., 2019). This thesis adopts the notion of a data 'ecosystem' because the term refers to the objective of a balanced interplay of stakeholders, deriving different kinds of value from their interaction in such a way that is self-sustaining (Cohen & Wendehorst, 2022; Jha et al., 2016).

Next to the smallholders, there are commercial stakeholders such as private companies, as well as governmental- and non-governmental organizations (NGOs) such as research and extension organizations or farmers' organizations that offer data-driven agricultural services as part of the SDE (Ferris & Rahman, 2016; Tsan et al., 2019). These entities offer their services directly to smallholders or as business-to-business (B2B) solutions to stakeholders such as extension agents, agribusinesses, financial institutions, or policymakers that take part in decision-making processes in smallholder value chains. Although data is the main resource harnessed in the SDE to function, the system also relies on human agents who facilitate advisory services, market access, logistics, and access to financial services (M. Nkomo, personal communication, August 4, 2022; Tsan et al., 2019).

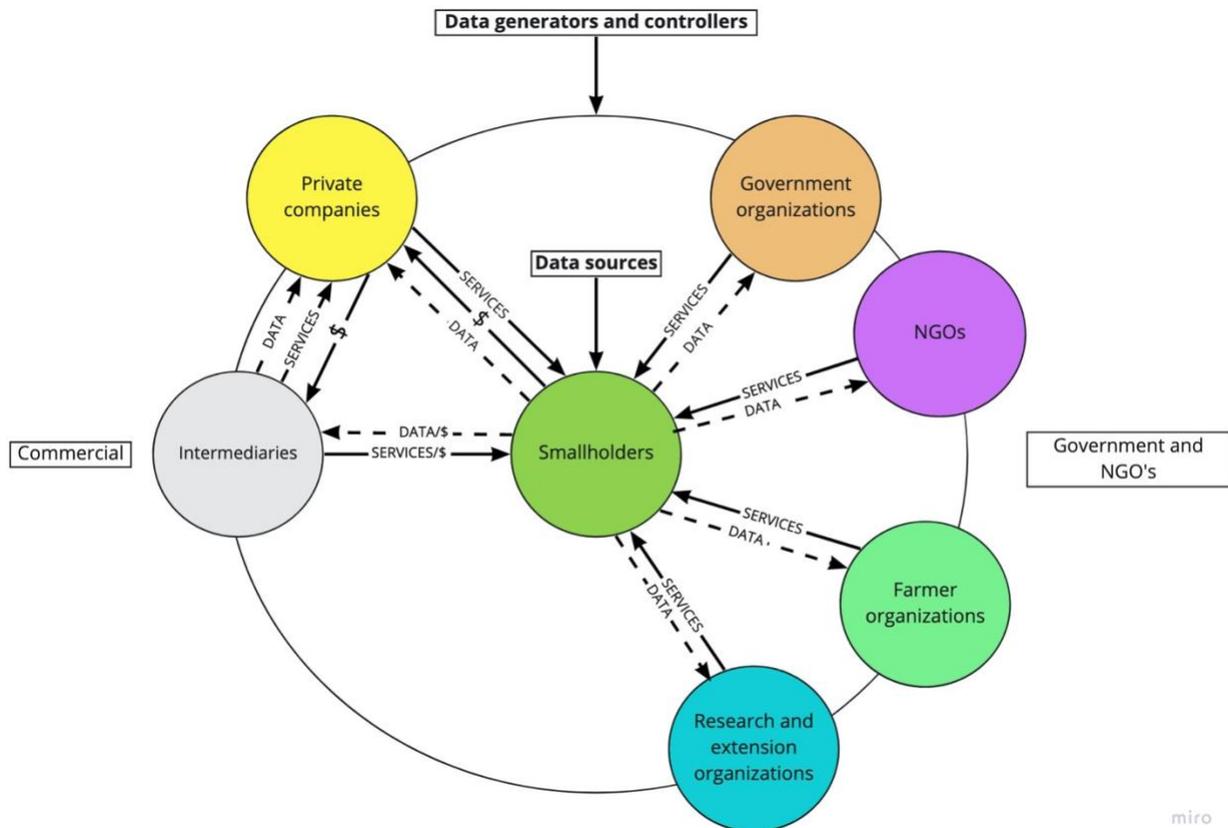
Figure 2 represents a simplified model of relevant stakeholders, their roles, and their respective system function in the SDE. The model is derived from Cohen and Wendehorst (2022), Ferris and Rahman (2016), and Gray et al. (2018). The distribution of roles could hence diverge in individual cases. However, the model intends to outline the underlying asymmetry of power between the

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<sup>5</sup> "The data economy is characterized by an ecosystem of different types of market players – such as manufacturers, researchers, and infrastructure providers – collaborating to ensure that data is accessible and usable. This enables the market players to extract value from this data, by creating a variety of applications with a great potential to improve daily life (e.g., traffic management, optimization of harvests or remote health care)" (European Commission, 2017, p.2).

stakeholders of the smallholder-data ecosystem. Figure 2 could, thus, help to understand the need for fair data governance principles to avoid exploitative data governance practices that could result in a form of digital colonialism if data is extracted and used without any resulting benefit being shared with the smallholders (Ferris & Rahman, 2016).

Figure 2: The smallholder data ecosystem. Synthesized from Cohen and Wendehorst (2022), Ferris and Rahman (2016), and Gray et al. (2018). Authors illustration.



Cohen and Wendehorst (2022) describe two main roles of stakeholders found in all data ecosystems. First, data "generators" are those stakeholders that contribute to the production of data. Data "controllers" or "holders", on the other hand, can access the data shared among the stakeholders and decide about the purposes and means of its processing (Cohen & Wendehorst, 2022).

Figure 2 depicts the smallholders at the center of the data ecosystem. This is because smallholders are the essential stakeholders in the scope of this thesis. Figure 2 furthermore shows better-resourced stakeholders on the outer ring, the primary stakeholders collecting and refining data in the SDE. The asymmetry in access to resources and information between smallholders

and better-resourced stakeholders is also noticeable in the distribution of roles in the data value chain. While smallholders often contribute to data production, they rarely collect and refine the data themselves. Hence, smallholders could also be described as data sources. However, better-resourced stakeholders often occupy both important roles in data ecosystems: data generators and controllers (Cohen & Wendehorst, 2022; Ferris & Rahman, 2016).

In the SDE, various stakeholders contribute to data production in distinctive ways. One important way of contributing to data production is by being the individual smallholder or farm subject of the information recorded in the data. Another way of contributing to the production of data is by recording information that was not recorded before (Cohen & Wendehorst, 2022). M. Nkomo, personal communication, August 4, (2022) further describes this process in practice as being either "active" or "passive" data collection. "Active" data collection is direct in the sense that individual farmers are interviewed by data collectors such as extension agents. "Passive" data collection, on the other hand, is done by data collectors without the involvement of smallholders, such as, e.g., using remote sensing technologies. Hence, based on the described processes of the system function 'data production', all stakeholders of the SDE can either actively or passively participate in the generation of data and are, therefore, data generators. However, while smallholders play a role in active data collection, passive data collection is mainly done by better-resourced stakeholders in practice (Ferris & Rahman, 2016; M. Nkomo, personal communication, August 4, 2022).

In the SDE, some stakeholders do not contribute directly to data production or collection but participate in value exchange by refining data in such a way that is more useful to other stakeholders (Cohen & Wendehorst, 2022). This is an important role since the quality of the services provided to smallholders depends on the quality of data in terms of relevancy for the smallholder and in terms of quantity and accuracy for the stakeholders refining the data (De Beer, 2016). The role of refining data, or in other words, making it useful to all stakeholders in the SDE, is mainly exercised by a third party, the intermediary consisting of better-resourced stakeholders such as private companies, NGO's or government organizations. Intermediaries usually facilitate the transactions between different stakeholders, such as parties producing and controlling data (Cohen & Wendehorst, 2022; Ferris & Rahman, 2016).

A practical example of a value exchange involving an intermediary could, e.g., involve a smallholder acting as a data (source) and an agricultural service provider acting as a data generator and controller. The data produced by the smallholder and collected by the agricultural service provider could then be transferred to a third party (intermediary) that is refining the raw

data to make it relevant to the agricultural service provider and smallholder farmer. The intermediary could then offer the refined data to the agricultural service provider or the smallholder, who can use it to derive economic, social, or environmental value from it, as described in Figure 1 (Ferris & Rahman, 2016; Solidaridad, 2022).

#### 1.4.4 Fair data governance

The concept of 'fairness' is central to the purpose of this thesis and therefore requires a clear definition to make the proposed principles more tangible to practitioners (E. Van de Ven, personal communication, August 4, 2022). The literature review uncovered that different interpretations exist on what constitutes 'fair' vis-à-vis the governance of value exchanges between stakeholders of data ecosystems (GO FAIR, 2016; RD, 2018). However, to conceptualize 'fair' or 'smallholder-oriented' data governance, this thesis synthesizes concepts associated with 'fair' or 'responsible' data governance and 'fair' trade in literature and practice and applies them to the described distinct context of the smallholder data ecosystem. First, the concept of 'fairness' will be discussed as it occurs in literature, existing data governance approaches, frameworks, and the practice of stakeholders of the SDE before proposing a typology of 'fair' data governance in data-driven smallholder agriculture.

Beyond the scope of data-driven smallholder agriculture, a wide range of approaches aim to govern the exchange of data. These include regulations such as the European General Data Protection Regulation (GDPR) (European Commission, 2017), human-rights-based approaches (United Nations, 2018), principles for 'responsible' and 'fair' data management (GO FAIR, 2016; RD, 2018), guides to data protection (WFP, 2016), codes of conduct (AG Data Transparent, 2014), principles for the data economy (Cohen & Wendehorst, 2022), or roadmaps for digital cooperation (United Nations, 2020) and more.

International organizations and research and extension organizations are essential stakeholders in constructing the groundwork for the global development of technical and normative data governance frameworks (Gasser & Almeida, 2022). The literature review uncovered that there are several diverse codes of conduct, principles, or operational standards sketching what is supposed to be 'fair' or 'responsible' handling of data even in the context of smallholder farming (Bayer et al., 2018; CGIAR, 2012; Chaves Posada, 2014; GFAR, 2018b; GODAN, 2022). These principles and 'good practices' should inform and encourage service providers in the SDE to implement a transparent and fair value exchange of smallholder data. However, because these

efforts are voluntary, it is not easy to assess their actual impact on smallholders or on Sustainable Development (Jouanrjean et al., 2020).

While these approaches vary in context and content, the literature review uncovered common reoccurring values in governing data equitably. Data governance can therefore be considered fair if it meets four fundamental criteria synthesized from literature:

- Accountability
- Transparency
- Empowerment
- Harm avoidance

All stakeholders should be accountable for the way they are handling smallholder's data because accountability is the basis for trust (GODAN, 2022; Mc Donald, 2021; M. Nkomo, personal communication, August 4, 2022; WFP, 2016). Furthermore, transparency and open decision-making processes that account for all stakeholder's interests are essential to determine whether decisions are justified (Fairtrade, 2022; Girard, 2019; GODAN, 2022; Mc Donald, 2021; Msengezi, 2019). Moreover, the empowerment of smallholders should be facilitated by fair data governance, e.g., by making information and learning accessible (Addision, 2018; Addom, 2019; Msengezi, 2019; Rambaldi, 2019; World Bank, 2016, 2017). Finally, smallholder-oriented data governance should also account for the avoidance of harm, e.g., by respecting the privacy and security concerns of smallholders (Addision, 2019; Mc Donald, 2021; M. Nkomo, personal communication, August 4, 2022; UN Global Pulse, 2019a, 2019b; WFP, 2016; World Bank, 2017).

The following section discusses the perspectives of representatives of three identified stakeholder groups, describing three distinct perspectives of the concept of 'fair' data governance in data-driven smallholder agriculture. First, as a representative of a commercial stakeholder, E. Van de Ven (personal communication, August 4, 2022) described a practical application of 'fairness' in her work within Rabobank's ACORN project<sup>6</sup> as follows:

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<sup>6</sup> ACORN is an initiative by Rabobank to harness the potential of data-driven smallholder agriculture to combine voluntary carbon sequestration with agroforestry projects (Rabobank, 2022).

“(…) fairness is just ensuring that farmers, over the long-term, get the highest price for their product, so they get the most benefit from what they are doing. Partly, that is making sure they (smallholders) get the biggest share of the revenue we can give them. But, also, to ensure that these farmers are treated consistently and that their work is valued consistently between different buyers” (emphasis added).

Additionally, E. Van de Ven (personal communication, August 4, 2022) stresses the value of contrasting desired against undesired behavior to make abstract concepts such as ‘fairness’ more tangible for companies in their everyday practice. In her experience, that could involve the development of benchmarks regarding the highest level of access to resources that smallholders can attain at a specific time. Any situation where this benchmark is not reached is hence ‘unfair’ because smallholders are kept from accessing the full potential of resources available to them. Contrasting the perspective of a practitioner representing a commercial stakeholder of the SDE, M. Nkomo (personal communication, August 4, 2022) represented the International Institute of Tropical Agriculture (IITA), a research institute for agricultural development. According to M. Nkomo (personal communication, August 4, 2022), ‘fair’ data governance in data-driven smallholder agriculture exists in situations where smallholders give up information but eventually get more in return than they gave up. An example of this practice could be a situation where a stakeholder collects data about smallholders, such as where they live and how the weather is precisely at this location. A stakeholder could then provide the smallholders with information about when it is the best time to plant a particular crop, thereby increasing the probability of a better harvest. Consequentially, any data governance practice that disadvantages, harms, or leaves a smallholder worse off than before, is unfair (M. Nkomo, personal communication, August 4, 2022). M. Nkomo (personal communication, August 4, 2022) further notes:

“(…) We are only having a conversation about fairness because we are trying to imagine what would be fair for this person (smallholders), but in doing so, they should not lose their agency. So, to look at what would be fair or unfair for smallholders, we need to look at it from their perspective” (emphasis added).

The perspective of social-good organizations such as Solidaridad is represented by H. Brouwers (personal communication, August 4, 2022). Brouwers reflected on experimental approaches to explore ways for responsible governance of smallholder data.

According to H. Brouwers (personal communication, August 4, 2022), Solidaridad defines two basic principles for 'fair' data governance in data-driven smallholder agriculture:

1. Smallholders must remain in control over their data.

According to H. Brouwers (personal communication, August 4, 2022), this also implies extensive efforts by stakeholders to collect data to receive inclusive consent from smallholders to use their data. The second principle is:

2. Smallholders should benefit from the value of data.

According to H. Brouwers (personal communication, August 4, 2022), smallholders can benefit from data in various ways. For example, H. Brouwers (personal communication, August 4, 2022) defined three levels in which smallholders can benefit from sharing their data with other stakeholders.

First, systems governing the data of smallholders should be designed for digital inclusivity, meaning that smallholders should have access to digital ecosystems. This concept is also often referred to as "bridging the digital divide" (H. Brouwers, personal communication, August 4, 2022). Furthermore, when "(...) looking at it from a macro level, we see that more people become part of digital ecosystems and digital platform services. However, for farmers in the Global South, there is the risk that they will miss this opportunity. Therefore, digital inclusivity must be a driving force" (H. Brouwers, personal communication, August 4, 2022). H. Brouwers, personal communication (August 4, 2022) further argued that access to digital ecosystems is already a value proposition on its own. In practice, smallholders could be enabled to access digital ecosystems when stakeholders offer access to digital services and mobile networks. They also contribute to educational programs that improve smallholders' digital literacy and training.

Second, smallholders can access all kinds of services once they have a digital identity. However, in the SDE, smallholders are confronted with the risk of lock-ins. According to H. Brouwers (personal communication, August 4, 2022), lock-ins happen when digital services providers deliver different tools and services based on data collected from the smallholder. Smallholders then become part of a data ecosystem controlled by a single provider, which limits their ability to access services by other providers and freely decide which offer is best for them. Hence, smallholders should always have access to all data ecosystems and service providers (H. Brouwers, personal communication, August 4, 2022).

A third way smallholders can benefit from the value of their data is by incentivizing and rewarding the sharing of their data and monetizing the data for them. For example, H. Brouwers (personal communication August 4, 2022) describes this as follows:

“Based on first trials, we (Solidaridad) believe in a model where farmers are incentivized directly at the moment they share their data. Whether the data is monetized later in the data value chain is not that relevant since that is up to the other stakeholders” (H. Brouwers, personal communication, August 4, 2022) (emphasis added).

Moreover, incentives for smallholders to share their data are crucial for the long-term sustainability of the relationship between smallholders and other stakeholders, especially if the goal is to move from accidental data collection to a continuous stream of data and daily interactions with smallholders (H. Brouwers, personal communication, August 4, 2022).

Based on the different perspectives and approaches presented in literature and applied in practice, it is still challenging to arrive at a comprehensive typology of what constitutes 'fair' data governance in smallholder farming. Furthermore, it is essential to note that most interpretations are based on descriptions of stakeholders from the Global North. Therefore, further research should capture more voices of stakeholders in the Global South to arrive at a more nuanced typology in the context of this thesis. This, however, lies outside the scope of this research project. Nevertheless, based on the literature review and stakeholder feedback, 'fairness', or fair data governance, in this thesis, is defined as balancing equitable relationships despite resource asymmetries among the stakeholders for a sustainable value exchange of data (GFAR, 2018a). 'Fair' and 'smallholder-oriented' can be used interchangeably, leading to the following working definition of 'fair' or 'smallholder-oriented' data governance in data-driven smallholder agriculture. *Fair or smallholder-oriented data governance defines the smallholder data ecosystem as being composed of multiple stakeholders with substantial resource asymmetries that choose to act in ways that account for responsible, adequately transparent, empowering, and harm-avoiding data handling in data-driven smallholder agriculture.*

#### *1.4.5 The problem with informed consent and digital sovereignty in the smallholder data ecosystem*

Hoppe (2010) defines problems in the context of governance as a mismatch between the status quo and the desired situation. This definition translates well to the challenges of receiving informed consent and achieving digital sovereignty in the environment of data-driven smallholder agriculture. The following section describes the status quo of two closely related concepts.

However, before the concepts of informed consent and digital sovereignty can be conceptualized regarding data-driven smallholder agriculture, the semantics must be disentangled as this constitutes an unstructured problem by itself (Hoppe, 2010).

When referring to the digital, scholars frequently distinguish the notion of 'sovereignty' when it comes to 'Data sovereignty', 'Technological sovereignty', and 'Digital sovereignty', among various other interpretations. Hence, a universally recognized definition of sovereignty as related to the digital does not exist since meanings vary along contexts and stakeholders (Couture & Toupin, 2019; Fabiano, 2020). However, the term must be defined in smallholder agriculture before it can be analyzed.

The term 'sovereignty' originates from political philosophy describing a state's authority to govern over its territory and people while deriving internal legitimacy from its people and external legitimacy from other states recognizing a state's authority to govern its people and territory (Hofmann & Matthias, 2022; Werner & De Wilde, 2001).

Also, the term 'data' is used differently among scholars. Cohen and Wendehorst (2022) point out that confusion can be caused by varying use of the terms 'information' and 'data'. The authors suggest that 'data' refers to "(...) information recorded in any form or medium, or being in a state of transmission" (Cohen & Wendehorst, 2022 p.30). However, in the case of this thesis and data-driven smallholder agriculture where digital data is addressed, this also means that "(...) data is more than the binary electrical impulse stored or being transmitted, as it includes context and semantics" (Cohen & Wendehorst, 2022 p.30).

By 'digital' this thesis adopts the conventional definition incorporating tools, ICT infrastructures, and data based on electronic computing (Couture & Toupin, 2019). When referring to the digital, the notion of sovereignty hence encompasses "(...) various forms of independence, control, and autonomy over digital infrastructures, technologies, and data (Couture & Toupin, 2019 p.1). From a state-centric perspective, sovereignty describes a state's effort to subject data flows to its national jurisdiction. However, the previous section showed that the smallholder data ecosystem

comprises various stakeholders that must be considered vis-à-vis fair data governance. Moreover, according to Polatin-Reuben and Wright (2014), a meaningful distinction can be made between weak and strong sovereignty. The authors define weak sovereignty as private, sector-led initiatives emphasizing data protection and the digital rights of stakeholders in the data economy. On the other hand, strong sovereignty describes a state-led approach focusing on national security (Polatin-Reuben & Wright, 2014).

Nevertheless, the notions of sovereignty when referring to the digital generally relate to "(...) meaningful control, ownership and other claims to data articulated by a variety of agents ranging from individuals to countries" (Hummel et al., 2021 p.1). Hence, ownership, control, and access to data are the cornerstones of the academic debate on digital sovereignty (Couture & Toupin, 2019; Daniels et al., 2020; Fabiano, 2020; Hummel et al., 2021).

Gehl Sampath and Tregenna (2022), Hofmann and Matthias (2022), and Makulilo (2015) provide some insight into African perspectives on digital sovereignty. Some authors argue that the core of the debate around digital sovereignty in Africa is about "Digital Colonialism". Understanding the reasons for this debate thus could help to understand how communities in the Global South interact with the diffusion of digital tools in their lives. According to Gehl Sampath and Tregenna (2022 p.92), "Digital colonialism is often characterized as the appropriation of big data by global technology companies in the data realm". Furthermore, global technology companies are often described with the notion of "surveillance capitalism", which is associated with exploiting personal data for financial gains (Gehl Sampath & Tregenna, 2022).

Eventually, the conceptualization of sovereignty as referring to the digital environment of data-driven smallholder agriculture underlines that context matters. The first necessary distinction is between state, collective, and individual sovereignty. Further, digital sovereignty is an elastic concept as it is connotated depending on how the stakeholders of the data economy try to legitimize their goals and methods (Hofmann & Matthias, 2022).

However, the literature review also uncovered that many of the accepted interpretations of identified key concepts are based on narratives of stakeholders from the Global North (Hofmann & Matthias, 2022). Therefore, striving for digital sovereignty in the context of smallholder farming requires finding a smallholder-oriented narrative on digital sovereignty. Furthermore, a state-led approach to digital sovereignty in smallholder farming could imply keeping or regaining more significant parts of the value chain on digital processes as key toward digital sovereignty (Hofmann & Matthias, 2022).

The concepts of informed consent and digital sovereignty are closely related in the context of data-driven smallholder agriculture. However, the literature review indicated that realizing these concepts in practice is challenging. According to the World Food Programme, the concept of informed consent can be summarized as such:

“The freely given and informed permission granted by the data subject (smallholder) to collect and process their personal data. Before granting permission, the data subject must understand: the intended purpose of this collection and processing; with whom this data may be shared; and any risks to their privacy that might stem from their data being collected and processed” (emphasis added) (WFP, 2016 p.5).

Five key criteria for identifying informed consent can be derived from this definition. In the context of data-driven smallholder agriculture, it implies that:

- Smallholders should give their permission freely, including the option to opt out of sharing their data
- Smallholders should be informed about the purpose of data collection and processing
- Smallholders should be informed about which parties can access and use their information
- Smallholders should be informed about risks originating from their data collection and processing
- Smallholders must understand the points they are informed about

However, Viljoen (2021) describes the aim of data governance as follows:

“(…) the relevant task of data governance is not to reassert individual control over the terms of one’s own datafication<sup>7</sup> (even if this were possible) or to maximize personal gain, but instead to develop the institutional responses necessary to represent the relevant population-level interests at stake in data production. This shifts the task (…) from providing opportunities for the exit, payment, or recourse, to securing recognition and standing to shape the purposes and conditions of data production, and thus establish the terms of legitimate mutual obligation”(Viljoen, 2021 p.64).

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<sup>7</sup> “Datafication is a technological trend turning many aspects of life into data which is subsequently transferred into information realized as a new form of value” (Wikipedia, 2022).

Viljoens's (2021) interpretation of the aims of data governance implies that it cannot be assumed that data governance can be a means for smallholders to gain control over their data and be sovereign in this regard. It further suggests that the stakeholders of the SDE will have to negotiate the purposes and conditions of data production to reach a status where the data production is legitimate to all stakeholders. As Fisher and Streinz (2021, p.83) point out, this approach would also legitimize data collection without consent "(...) as long as the purposes and the conditions of such collection are derived from legitimate forms of collective self-willing and further legitimate public ends".

According to Fisher and Streinz (2021), the underlying legal uncertainty around data ownership constitutes a significant challenge regarding the assessment of legitimate data collection. Data generators in data ecosystems often assume an intellectual property-like character of data which incentivizes them to generate data through collection or refinement. This, however, ignores that, in practice, stakeholders are rewarded who see data as a *res nullius*: "things that belong to no one but can be claimed by whoever catches them first" (Fisher & Streinz, 2021, p.36). This misleading appraisal of data as intellectual property likely arises from path dependencies due to data being intangible as other things subject to intellectual property protection by law. The authors further note that:

"The discourse is often plagued by conflating the normative case for recognizing property rights in personal data to address concerns around individual privacy and the excesses of "surveillance capitalism", with the broader questions about whether data, both personal and non-personal, already lends itself to property protections under existing law (Fisher & Streinz, 2021 p.36).

This debate also has implications for the SDE, as M. Nkomo (personal communication, August 4, 2022) points out. M. Nkomo (personal communication, August 4, 2022) challenges the basis on which a distinction between personal and farm data can be made in the context of data-driven smallholder agriculture as he emphasizes considering the distinct context of smallholders. "If you have been on any of the smallholder farms in most parts of Africa, or even in South-East Asia and Latin America, you realize that for people's personal space, there is no demarcation where they consider this to be the end of their personal space and the beginning of their farm space because their farms are integrated into who they are". For instance, M. Nkomo (personal communication, August 4, 2022) points out that most of the coffee farms in Kenya or Latin America are in people's

homesteads. Hence, no criteria could be applied to determine a demarcation between a smallholder's personal and farm space.

Stakeholders of the SDE are aware of the theoretical and practical challenges involved in getting smallholders' approval to use their data (H. Brouwers, personal communication, August 4, 2022; M. Nkomo, personal communication, August 4, 2022; E. Van de Ven, personal communication, August 4, 2022; C. Witkowski, personal communication, 2022). However, on the subject of inducing consent, Razzano (2020) points out that the consenting party (the smallholder) always risks being exposed to different forms of control. Therefore, focusing "(...)" on individualised consent as *the* mechanism for the exercise of a freedom, in this (...) context, has one net result: Consent without power leads to inequality" (Razzano, 2020, p.5)(emphasis added). The author further argues that when decisions on what is ethical or fair are exclusively determined by well-resourced stakeholders that hold significantly more power, the risk of reproducing existing power asymmetries continues. Razzano's (2020) critique on the relationship between consent and an individual's ability to take a sovereign decision has significant implications in the SDE as M. Nkomo (personal communication, August 4, 2022) notes: "(...) People (data collectors) say we've got prior consent. But actually, the farmer because of the asymmetry of information and the power relations, was not going to say no anyway)" (emphasis added).

However, H. Brouwers (personal communication, August 4, 2022) and C. Witkowski (personal communication, 2022) argue that while the challenge is receiving consent from farmers to collect and use their data legitimately and transparently is widely acknowledged among practitioners, it is still possible to generate it. However, receiving informed consent from smallholders is complicated and time-consuming. H. Brouwers (personal communication, August 4, 2022) further notes that the cost of data collection is already high. Extensive and complicated consent procedures hence contribute to the overall cost levels. Consequently, data generators have a cost incentive that is contradictory to the interests of smallholders to take a well-informed and sovereign decision about how their data should be treated.

Nevertheless, according to H. Brouwers (personal communication, August 4, 2022), some stakeholders, such as Solidaridad, are looking for ways to improve this situation. In practice, the situation and information available to smallholders differ from country to country. However, the conditions of the data collection and privacy regulations must be summarized in a condensed way and made available in the local language. If farmers cannot read or write, it needs to be processed in such a way that it is either read to them face-to-face or through the use of text-to-speech technology, where it is also made available in an audio format (H. Brouwers, personal communication, August 4, 2022). "In the end, everything is related to ethical data treatment and

processing. In our opinion, that goes with strict and inclusive consent procedures” (H. Brouwers, personal communication, August 4, 2022).

### 1.5 Problem statement

Data in the global data economy conveys significant social, economic, and political power. However, unequal control over data is a widespread form of digital inequality in many data ecosystems such as the SDE. This digital divide is a problem for Sustainable Development, human agency, and individual and collective self-determination that needs to be addressed (H. Brouwers, personal communication, August 4, 2022; Fisher & Streinz, 2021).

Data-driven agriculture promises to boost Sustainable Development by improving the livelihoods of smallholders, their families, and communities, as well as environmental protection by making farming practices more efficient and allowing smallholders to access valuable information (Maru et al., 2018). However, the smallholder data ecosystem is subject to a significant power imbalance resulting from differently resourced, capable, and informed stakeholders (Ferris & Rahman, 2016). Nevertheless, there are no benchmarks vis-à-vis the 'fairness' of smallholder's data governance, mainly which attributes a data-governance system should have to ensure fair and sustainable benefit-sharing from smallholders' data. This situation leaves smallholders vulnerable to the unfair and unsustainable collection and use of their data (H. Brouwers, personal communication, August 4, 2022; Fisher & Streinz, 2021; Quayson et al., 2021).

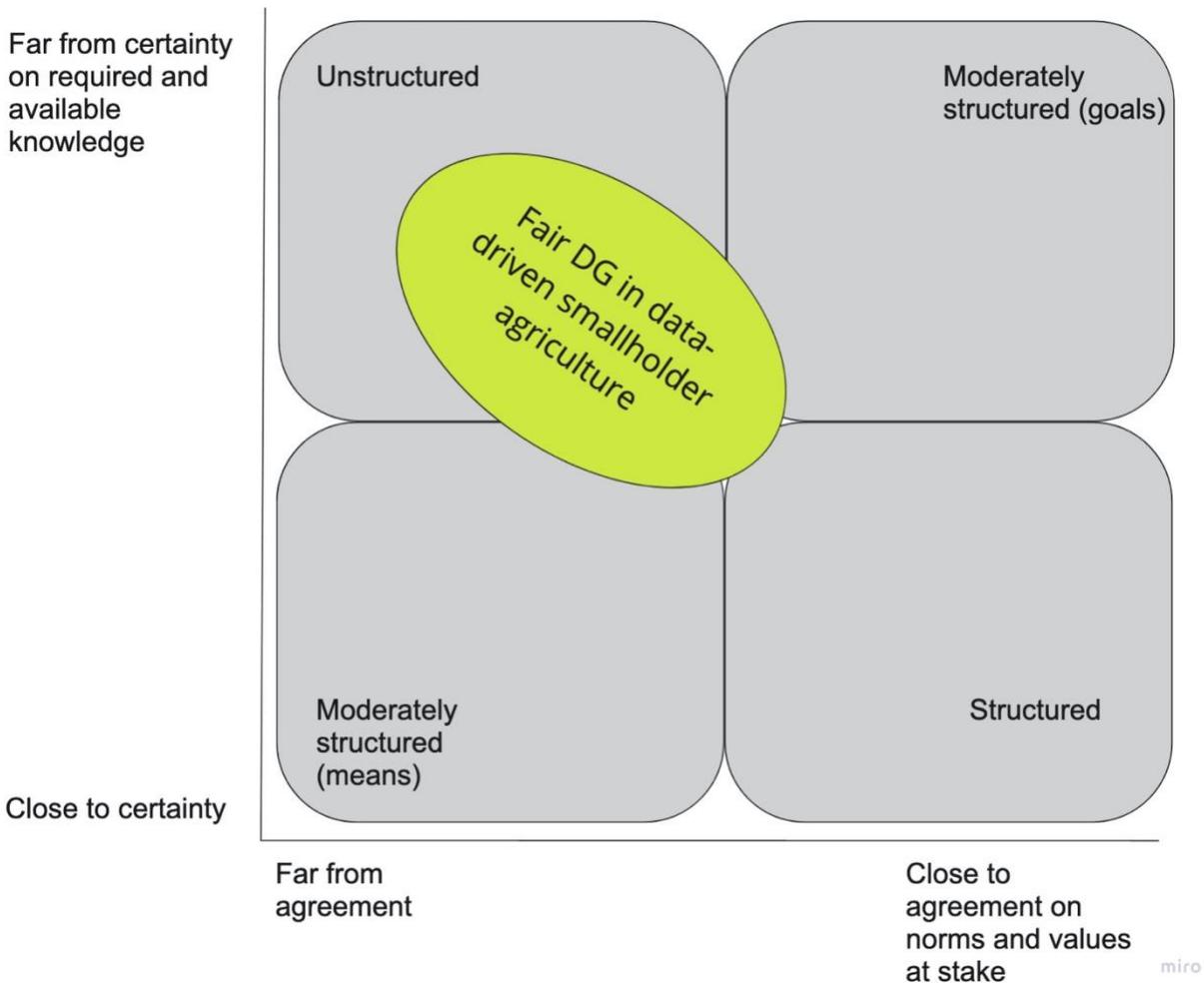
This thesis argues that the need exists to develop a smallholder-oriented data governance framework before potentially harmful or unsustainable data governance practices are established. Inert policymaking, consequently, risks consolidating path dependencies in a dynamically changing smallholder data ecosystem that can obstruct the establishment of smallholder-oriented data governance practices (Sharp et al., 2022; Stalla-Bourdillon et al., 2020). Therefore, this thesis intends to contribute to formulating basic principles that could inform stakeholders and decision-makers in the smallholder data ecosystem to develop fair and sustainable data governance policies.

As outlined in the literature review, the foremost challenge to fair data governance in the context of smallholder farming is about preventing the potential of better-resourced stakeholders in the ecosystem to misuse their position of power to control the exchange of smallholders' data at the expense of smallholders and Sustainable Development (Ferris & Rahman, 2016; Fisher & Streinz, 2021; Mc Donald, 2019). The challenge to establishing fair data governance practices

among stakeholders can thus be classified as a sustainability problem because it encompasses local issues of smallholders in the Global South, such as poverty, hunger, decent work, economic growth, the reduction of inequalities, and global ethical issues concerning the fairness of global trade and equitable supply chains (Kates et al., 2001; Solidaridad, 2022; The Living Income, 2021).

Based on the data collection and analysis conducted for this thesis project, a problem was identified, which is addressed in this thesis. The problem relates to the central research question and the establishment of principles for fair data governance in data-driven smallholder agriculture. The following figure classifies the problem primarily as an unstructured problem in Hoppe's (2010) problem typology.

Figure 3: Problem structure of fair data governance in data-driven smallholder agriculture. Based on Hoppe's (2010) problem typology.



Fair data governance in data-driven smallholder agriculture was classified in this thesis as an unstructured problem because the data collection and analysis uncovered deviation among stakeholders and authors in academic and gray literature about the goals of fair data governance in data-driven smallholder agriculture, particularly to what extent the concept of digital sovereignty could be achieved in the SDE (H. Brouwers, personal communication, August 4, 2022; Fisher & Streinz, 2021; M. Nkomo, personal communication, August 4, 2022; Viljoen, 2021; C. Witkowski, personal communication, 2022). Furthermore, due to the normative nature of the research topic, scientific certainty cannot be established in the reductionist sense. Additionally, the lack of a commonly acknowledged set of principles for fair data governance in data-driven smallholder agriculture discussed in academic literature indicates uncertainty in the knowledge available. Therefore, this thesis takes a post-normal approach to science, further explained in the following chapter.

However, the dimensions of Hoppe's (2010) problem typology are not inherently dichotomous, as in the case of fair data governance in data-driven smallholder agriculture. This is because problem types can change over time and cannot be defined objectively due to their nature of being socially constructed (Hoppe, 2010). Additionally, this classification can also be a result of the limited scope of this thesis. It could change when the peer community is extended to all stakeholders, including smallholders or their organizations (Funtowicz & Ravetz, 1993).

To consolidate the relationship between science and policy development Pielke (2007) argues that scientists should choose a particular role to avoid politicizing their work. Essentially, the problem at stake involves normative considerations about fairness and political concepts such as sovereignty. The principles, however, were formulated to enhance a particular stakeholder's (smallholders) position within a governance system. Hence, this thesis was written from the perspective of an issue advocate. Taking on the role of an issue advocate can help provide knowledge beyond empirical facts by limiting the scope of choice provided to stakeholders to make the problem more structured (Pielke, 2007).

## 1.6 The theoretical framework and knowledge gap

The literature review uncovered that the management of smallholder data becomes of growing relevance for Sustainable Development because of the data's potential to empower smallholders in the value chain through access to information and infrastructure, provide additional income or reduce adverse effects of farming on the environment (Miller et al., 2013; Solidaridad, 2022). In other words, practitioners seem to agree about the potential benefits of smallholder-oriented data

governance. However, despite calls for principles and standard setting regarding legal, privacy, or technical challenges, such as in “Mobilizing the data revolution for Sustainable Development” by United Nations (2014), there is still a lack of a harmonized sector-wide framework for accountable, sufficiently transparent and responsible data governance in data-driven smallholder agriculture (Rambaldi, 2019; UN Global Pulse, 2019b, 2019a; UNDG, 2017; WFP, 2016). This knowledge gap is a problem because there exists no clarity on what constitutes fair data governance in data-driven smallholder agriculture. Consequently, there is no certainty among stakeholders on how smallholders’ data should be managed in respect of Sustainable Development.

The literature review further uncovered that the concepts of data governance and digital sovereignty provide a feasible conceptual framework through which the research gap and research questions of this thesis can be addressed. Data governance is already widely discussed in the context of Sustainable Development (K. J. Bowen et al., 2017; Carolan et al., 2015; Krishnan, 2022; Smith, 2014; UNDG, 2017; United Nations, 2018; Weitzberg et al., 2021). Digital sovereignty and fairness, however, appear to be understudied in the context of data-driven smallholder agriculture especially with regard to the impact of data-driven tools and services.

Based on the identified knowledge gap, the problem structure, and the research aims of this thesis research project, this thesis's theoretical orientation is in the post-normal sciences field. According to Funtowicz and Ravetz (1993, p.750), "(...) post-normal science occurs when uncertainties are either of the epistemological or the ethical kind, or when decision stakes reflect conflicting purposes among stakeholders". The post-normal sciences approach was chosen for this thesis project because of high system uncertainties due to many stakeholders in the SDE with different values and objectives (which could not be clarified in this thesis due to its limited scope). Furthermore, the stakeholders in the SDE are connected through global value chains, and the decision stakes are high, especially for the less-resourced smallholders, but also in terms of Sustainable Development.

### 1.7 Research aims and objectives

Smallholder-oriented data governance could be a more sustainable approach to social change in the context of data-driven smallholder farming due to its focus on Sustainable Development and fairness as core objectives. Therefore, this thesis intends to propose a set of principles that could inform stakeholders in the smallholder data ecosystem about indicators for fair governance of farmers' data in the context of the Sustainable Development Goals. Hence, the contribution to the

science of this thesis project is to improve scientific certainty regarding what constitutes fair data governance in data-driven agriculture by exploring the perspectives of scientists and stakeholders of the SDE regarding fairness in data governance.

Based on the Sustainable Development challenges in smallholder farming, the literature review, and the problem statement, the aims for this research project were formulated in line with the FSD project. Hence, this thesis proposes a set of principles and their enabling conditions that stakeholders could apply in the smallholder data ecosystem to ensure fair governance of farmers' data in line with the Sustainable Development Goals. Furthermore, these principles are supposed to provide a basis for the FSD project further to develop its principles for 'fair' data governance.

To uncover the enabling conditions for smallholder-oriented data governance principles in data-driven smallholder agriculture, this thesis aims at answering the main research question 'which attributes make for smallholder-oriented data governance in data-driven smallholder agriculture?'. Ultimately, the thesis will develop a set of principles for smallholder-oriented data governance in data-driven smallholder agriculture that is relevant and practical for the stakeholders in this data ecosystem.

To do this, the thesis explored the challenges and benefits of data-driven agricultural business models and projects for smallholders in the literature review. It further aims to identify elements of fair data governance that are relevant and practical and can be applied across data-driven smallholder agriculture by involving stakeholders. However, the thesis did not study smallholder farmers or their practices. Instead, it focused on a systems perspective of the smallholder data ecosystem in data-driven smallholder agriculture. Therefore, the proposed principles are not a concrete set of policies but the definitions of general enabling conditions of fair data governance in data-driven smallholder agriculture in the Global South. These principles aim to inform the development of transparent, empowering, and long-term dedicated approaches to using smallholders' data and to enact the necessary change toward sustainable development.

To achieve the stated goals, this work observed the leading objective of delivering a thesis in the field of Sustainability Science. That means that the end product should be credible and legitimate in the sense of being trustworthy through the transparent methodology and salient by reflecting on the relevancy and practicality of the proposed principles to put knowledge into action for Sustainable Development (Matson et al., 2016; Parker & Crona, 2012).

## 1.8 Research questions

The review of the literature uncovered that data governance and digital sovereignty are essential concepts when it comes to assessing the relationship between smallholders and other stakeholders and the role data plays in this relationship to support Sustainable Development. At the same time, these concepts, in the context of data-driven smallholder agriculture, are not widely discussed in academic- and gray literature. Therefore, this thesis project investigated the following research questions.

The first research question, *'how and to what extent does smallholder-oriented data governance contribute to sustainable smallholder agriculture and subsequently to Sustainable Development?'* was addressed in the first part of the thesis, the systematic literature review. The second research question, *'what is the contemporary understanding of fair data governance and digital sovereignty in the smallholder data ecosystem?'*, also builds on the definitions developed in the systematic literature review and draws from stakeholder and practitioner feedback insights. To answer the main research question of this thesis and to be able to meet the objectives of this research project, a theoretical model of smallholder-oriented data governance in data-driven smallholder agriculture synthesizes the findings of the previous chapters by developing a set of general principles to answer, *'which attributes make for smallholder-oriented data governance in data-driven smallholder agriculture?'*

## 2. Research design

The following chapter outlines the approach taken in this thesis research project. This chapter further describes the methodology applied in each step of this thesis and describes the limitations encountered in practice.

This thesis applied a qualitative approach to an exploratory research project by means of Grounded Theory. Grounded Theory was chosen as a methodological approach because it allows open processes and theory development with a more contextual focus and diverse data formats such as various forms of qualitative data (Patten & Newhart, 2018; Sustainabilitymethods.org, 2021). The Grounded Theory approach proved helpful in this exploratory study as it allowed for an open-minded conceptualization of the data collected. Furthermore, induction helped create codes and structure encountered concepts that explain interdependencies regarding the research topic.

The research was conducted between May and August 2022 and adopted the thematic, social, and geographical scope of the FSD Project, thus focusing on the implications of data-driven smallholder agriculture on smallholder farmers and sustainable development in the Global South.

### 2.1 Data collection and analysis

The primary method for data collection in this research project was desk research and stakeholder and practitioner feedback. Data collected during desk research and the stakeholder and practitioner feedback was analyzed using coding as described in Bowen (2009), Flick (2018), and Sustainabilitymethods.org (2021). Data management techniques involved coding in tables, transcription, and personal notes.

The desk research was conducted as a systematic literature review which yielded journal articles and gray literature documents. The systematic literature focused on analyzing documents on challenges regarding the conceptual framework represented by the concepts of data governance, digital sovereignty, and 'fairness' in data-driven smallholder agriculture. Therefore, this thematic analysis involved recognizing patterns within the selected data through coding and constructing respective categories to uncover themes relevant to a phenomenon (Bowen, 2009). This approach proved helpful in effectively structuring information gathered from more than 150 sources relating to the conceptual framework.

### 2.1.1 Desk research – The systematic literature review

The systematic literature search was conducted between May and June 2022, guided by Maastricht University Library search planning form. Four predominant concepts were derived from the research questions and a preliminary review of the literature using coding: (1) Data Governance, (2) Digital Sovereignty, (3) Sustainable Development, and (4) Smallholder Agriculture. These concepts provided the basis for the creation of relevant search terms, which were: (1) Data, Data Governance, Digital Governance, Digital Policy, Data Management, Digital Transformation, Farm Data, Ethical Governance Theory, (2) Digital Sovereignty, Digital Sovereignty, Digital Multiplicity, Digital Participation, Digital Colonialism, Technological Sovereignty (3) Sustainable Development, Sustainable Development Goals, SDG, Agenda 2030, Data for Sustainable Development, D4Ag (4) Smallholder Farming, Agriculture, Subsistence Farming, Small-scale Farming, Family Farming, Peasant Farming.

The search terms were developed using Visuwords, an online graphical dictionary, and by synthesizing reoccurring concepts from literature related to the research topic, such as 'Fair Data' or 'Responsible Data' management and governance. Furthermore, backward reference searching with Connected Papers helped to identify relevant literature.

Databases searched were: Open Knowledge Maps, Web of Science, PNAS, Google Scholar, and Open Access Journals for academic literature.

In addition, gray literature documents and publications were found open-access databases and websites of organizations and practitioner-consortia active in research and field- and extension work in smallholder agriculture. These included: the Technical Centre for Agricultural and Rural Co-operation (CTA), Consultative Group for to Assist the Poor (CGAP), Food and Agriculture Organization of the UN (FAO), Global Forum on Agricultural Research and Innovation (GFAR), Global Open Data for Agriculture and Nutrition (GODAN), Solidaridad, Sector Network Rural Development Africa (SNRD), German Institute of Development and Sustainability (IDOS), Consultative Group for International Agricultural Research (CGIAR). In sum, more than 150 sources originating from journal articles, gray literature documents, and publications of these organizations were reviewed to build a solid foundation for the literature review.

Finally, to structure the systematic literature search of this thesis project, a set of inclusion and exclusion criteria had to be defined. In summary, sources were selected for relevancy by applying the following criteria:

Inclusion criteria:

- Academic and gray literature articles, documents, and websites converging challenges in data-driven smallholder agriculture and Sustainable Development
- Sources discussing the implications of digitalization in the context of smallholder agriculture
- Sources discussing digital sovereignty, data governance, and fairness

Exclusion criteria:

- Sources older than ten years (in the case of sources that cover the status quo of digitalization in smallholder farming)
- Sources that do not match the inclusion criteria and are found to be irrelevant to answering the research questions

### 2.1.2 Development of the principles

The model set of principles was developed to deliver exploratory research to the FSD Spearhead as a basis to inform the development of its data governance principles for the Fair Farm Data ecosystem. The principles, therefore, had to be relevant and practical to the stakeholders of the FSD Spearhead and other stakeholders of the SDE. A second necessary condition guiding the development of the principles was the requirement to be relevant in the context of Sustainability Science and Sustainable Development, respectively. Therefore, a set of appropriate criteria for developing the principles was defined to match the expected scope of the principles. The following criteria were applied for developing the theoretical model of smallholder-oriented data governance in data-driven smallholder agriculture:

- The principles account for the thematic areas identified in data-driven smallholder agriculture and data governance challenges.
- The principles are practical and relevant for the stakeholders in data-driven smallholder agriculture/ the smallholder data ecosystem.
- The principles are consistent with the SDGs.

Additionally, since the literature review uncovered four essential concepts associated with 'fair' or 'responsible' data governance, the proposed principles must also address the following criteria:

- Accountability
- Transparency
- Empowerment
- Harm avoidance

The consistency of the proposed principles with the described criteria was later verified by exposing a draft set of principles to scrutiny by stakeholders and practitioners of the SDE. However, the following section will reflect on the process of the stakeholder and practitioner feedback. In summary, the systematic literature review constituted the basis for preparing a set of draft principles that contained a synthesis of the identified concepts related to smallholder-oriented data governance in data-driven smallholder agriculture. The purpose of outlining a draft set of principles was first to summarize the findings in literature in a concise format that could be used as the basis for discussion with stakeholders and practitioners of the SDE. For this, a document was created which contained relevant information about the context of the thesis, the method, and the criteria used for creating the draft set of principles.

### 2.1.3 Stakeholder and practitioner feedback

The feedback objective was to expose the draft principles to scrutiny by stakeholders and practitioners of the smallholder data ecosystem and to receive feedback regarding their relevancy and practicality. The stakeholder and practitioner feedback was gathered in the format of semi-structured interviews as described in Coghlan and Brydon-Miller (2014). Essentially, the purpose of the stakeholder and practitioner feedback (by organizations and individuals) was to validate the preliminary literature review findings and the draft set of principles. Based on their experience, the identified stakeholders and practitioners were asked to scrutinize a set of draft principles regarding relevancy and practicability for smallholder-oriented data governance. The stakeholder and practitioner feedback revealed that the research questions posed by this thesis are salient for the stakeholders in the SDE. Furthermore, the problem typology specified in the problem statement suggested involving an "(...) extended peer community, consisting of all those with a stake in the dialogue on the issue (...)" (Funtowicz & Ravetz, 1993, p.739)" to ensure the quality of scientific inputs.

However, the following criteria were applied in selecting relevant stakeholders and practitioners to ensure the credibility of the feedback:

- Respondents must be a stakeholder in the smallholder data ecosystem.
- Respondents must have academic or practical experience in data-driven smallholder agriculture or responsible data governance.
- The feedback should cover all stakeholder groups present in the smallholder data ecosystem.

The respective stakeholders were identified using snowball sampling as described in Flick (2018) in the case of affiliates of the FSD project as well as authors and organizations encountered during the literature review. The snowballing method yielded a set of 13 individual practitioners and organizations that met the criteria. Stakeholders and practitioners were approached via email, which stated the purpose and objectives of the research as well as the value of individual participation. Further, the email contained a summary of the draft set of principles, an explanation of their relevance for smallholders, and a set of enabling conditions that could function as criteria to determine whether a respective data governance system observes a respective principle or not. In addition, stakeholders and practitioners were asked to point out weaknesses and suggestions for improvements to the draft principles along with a selection of a few guiding questions:

- Are any central concepts missing or not sufficiently outlined that you consider relevant for smallholder-oriented data governance?
- Would you suggest arranging or emphasizing any principle or concept differently? If yes, how?
- Do you consider the proposed principles and their enabling conditions practical for data-driven smallholder agriculture? Can you think of challenges in this regard?
- Would you still qualify a DG regime that does not satisfy all enabling conditions as being smallholder-oriented? Are there some conditions that must be satisfied and others that are not strictly necessary?

The approached stakeholders were offered to give their feedback in the form of individual semi-structured interviews or written feedback to increase the likelihood of receiving feedback. However, in practice, all stakeholders chose the option of individual 30–60-minute semi-structured

interviews. In addition, four stakeholders were interviewed who work with organizations occupying the role of data generators and data controllers in the SDE. The third criterium 'the feedback should cover all stakeholder groups present in the smallholder data ecosystem, constituted a challenge, and was only partially met. Consequently, the number of stakeholders and practitioners willing to participate in this research within the time constraints was low. Although the sample size for the stakeholder and practitioner feedback is relatively small, it was sufficient to verify the relevancy and practicality of the intermediate results. Furthermore, the feedback was nevertheless provided by stakeholders that covered diverse backgrounds such as research and extension organizations (M. Nkomo, personal communication, August 4, 2022), private corporations (E. Van de Ven, personal communication, August 4, 2022), social-good NGOs (H. Brouwers, personal communication, August 4, 2022) and a hybrid entity (C. Witkowski, personal communication, 2022).

## 2.2 Limitations of the research design and encountered challenges

The same limitations to data collection and analysis apply to this thesis as to other qualitative studies and applications of Grounded Theory. Despite the laid-out advantages of this approach, the primary method used for data analysis in this thesis, coding, significantly depends on the experiences and preferences of the researcher. Hence, existing biases could manipulate the results in such a way that the conclusions are incredible (Sustainabilitymethods.org, 2021). However, the stakeholder and practitioner feedback helped to mitigate this pitfall in methodology by peer review of the draft principles and enabling conditions.

Transparency and ambiguity are also challenges in qualitative research approaches that apply to this thesis (Sustainabilitymethods.org, 2021). This thesis, however, tried to balance these challenges by transparently explaining the research process, on what basis criteria were developed, and how they were used to inform the final product of this research project.

Next to challenges in the methodological approach, this research project was also limited regarding stakeholder participation. The response rate of stakeholders and practitioners contacted to receive feedback on the draft principles was lower than expected, primarily due to the unavailability of stakeholders and practitioners for personal reasons. Nevertheless, the stakeholder and practitioner feedback indicated the relevancy and practicality of the proposed principles, which supports the credibility of the final product. However, the lack of participation of smallholders in the research process can be seen as a noticeable pitfall. Therefore, forthcoming research projects should consider means of involving smallholders to ensure their voices are acknowledged, especially when the proposed principles are used for developing policies (Kalita

et al., 2012). This thesis, however, argues that the lack of smallholder involvement does not undermine the legitimacy of the research results or proposed principles. First, that is because the principles are mainly intended to inform the better-resourced stakeholders of the SDE, particularly the FSD Spearhead, regarding principles based on various definitions of fairness. Secondly, the principles are not a concrete set of policies but the definitions of general enabling conditions for smallholder-oriented data governance. Hence, these principles aim to inform the construction of transparent, empowering, and long-term dedicated approaches to using smallholders' data to enact the necessary change toward sustainable development.

Conclusively, the products of scientific studies taking a Grounded Theory approach should be interpreted as “(...) a deeper look into societal structures, power, agency and the actions of individuals embedded in society and their milieu” (Sustainabilitymethods.org, 2021) and not as facts in the reductionist sense (Funtowicz & Ravetz, 1993; Hoppe, 2010).

### 3. A theoretical model of fair data governance in data-driven smallholder agriculture

The following chapter comprises the main result of this thesis research project: a set of five principles and ten enabling conditions for fair data governance in data-driven smallholder agriculture. The principles are based on the findings of the systematic literature review and the stakeholder and practitioner feedback. Furthermore, the stakeholder and practitioner feedback conducted for this thesis also improved the credibility of the results by verifying their relevancy and practicality. Due to the criteria applied in developing the proposed principles, they describe a more sustainable approach to social change in data-driven smallholder agriculture with Sustainable Development and fairness as core objectives.

First, the respective principles are introduced, and explanations for their relevance in fair smallholder data governance are given. Secondly, the respective enabling conditions for each principle are listed, which could help stakeholders to identify whether a principle is satisfied in practice. Thirdly, the implications of the results are discussed for each of the research questions. All principles and their respective enabling conditions are structured in a non-hierarchical order.

#### 3.1 Ethical Professionalism

Ethical Professionalism, or ethical responsibility and accountability, addresses the unequal power distribution among stakeholders in the SDE. The principle of ethical Professionalism aims to establish equitable relationships by creating accountability among stakeholders. This thesis identified three enabling conditions that could help recognize this principle in practice:

1. Stakeholders understand the socio-economic systems they are operating in.
2. Data collection and processing are legitimate.
3. Stakeholders recognize responsibility and accountability for fair data governance.

The significant underlying asymmetries of information, power, finances, and expertise between better-resourced stakeholders and smallholders originate from insufficient availability and accessibility to data and resources for smallholders (Ferris & Rahman, 2016). This situation must be addressed when developing policies for smallholder-oriented data governance. The underlying premise from this observation is that better-resourced stakeholders such as private companies, government organizations, research and extension organizations, or social good organizations are subject to greater responsibility and high standards of integrity and stewardship in smallholder-oriented data governance. Better-resourced stakeholders primarily act in the role of data controllers and, therefore, should also act as agents for smallholders.

Furthermore, the legitimacy of data collection is central to the fairness of smallholder-oriented data governance. Although balancing different interests can be costly and cause conflicts among stakeholders, legitimate data collection must account for the interests of smallholders whose data is being used. That also implies establishing ways for meaningful participation in decision-making processes. Additionally, the accountability of intermediaries is the basis for trust in a governance system. Hence, accountability is particularly relevant in the context of fair data governance in data-driven smallholder agriculture because of the challenges in receiving reliable informed consent from smallholders.

The willingness of better-resourced stakeholders to take responsibility for their data handling is a prerequisite for engaging in fair data governance with smallholders. Therefore, the latter must understand their operating socio-economic system to bridge the power and resource gap between smallholders and data controllers. That involves understanding the political and cultural environment and aligning with existing technological, legal, and regulatory policies. In varying contexts, it is possible that legal and regulatory frameworks do not address the effects of data and technology use in smallholder agriculture. Suppose such regulatory loopholes are encountered, as, e.g., privacy protection standards vary from country to country. In that case, it is crucial to make transparent which measures are in place to avoid exploitative data governance practices (practices where smallholders do not derive a benefit from the provision of their data).

### 3.2 Sustainable Benefit-Sharing

The principle of Sustainable Benefit-Sharing is based on the premise that Sustainable Development and the fair sharing of benefits derived from smallholders' data should be imperative in smallholder-oriented data governance. Therefore, smallholders must derive tangible value from data sharing and engaging in data governance. The enabling condition for sustainable benefit sharing is hence:

4. All stakeholders receive consistent benefits from participating in data governance.

Value propositions to smallholders can, e.g., be offered in the form of improved yield, a more powerful position in the value chain, or higher income and financial incentives for their data provision (H. Brouwers, personal communication, August 4, 2022; Solidaridad, 2022). Further, sustainability implies the establishment of business models and infrastructures that are long-term

socially, environmentally, and economically oriented (Bocken et al., 2014). That can be ensured by multipurpose business models that yield benefits for all stakeholders (H. Brouwers, personal communication, August 4, 2022; E. Van de Ven, personal communication, August 4, 2022). The absence of benefit-sharing, however, could be a clear indicator of digital colonialism, or in other words, the extraction and use of data without any subsequent benefit received by the smallholder farmer (Ferris & Rahman, 2016).

### 3.3 Legitimate Expectations of Privacy and Security

The principle of legitimate expectations of privacy and security is based on the premise that in the SDE, smallholders have a reasonable expectation or interest in other stakeholders to protect their data privacy and security and establish all necessary means to retain that expectation. This principle is vital, especially, in contexts where smallholder data is not protected by legal frameworks (Olinger et al., 2007; Razzano, 2020).

Smallholders qualify as a vulnerable community because of their limited access to resources and the lack of fundamental rights (Quayson et al., 2021). Therefore, mishandling smallholder data can expose them to severe harm (Gray et al., 2018). Therefore, smallholder-oriented data governance relies on establishing clear data collection and processing rules, including agreements on who can access and edit smallholders' data. Furthermore, a monitoring and enforcement mechanism for the established rules could identify and protect the sensitive data of smallholders.

Security for smallholders' data also means understanding the risks associated with collecting and processing their data. Just because data can be used in a certain way does not mean it should be. All stakeholders should understand what will be done with the data and for what purpose it was generated in the first place. Where smallholders are not transparently informed, the data collecting or refining stakeholder should be accountable for any harm resulting from breaches to smallholders' data security and privacy, as already implied by the principle of ethical Professionalism. Damages caused by data breaches or misappropriation could have severe effects on smallholders. Therefore, stakeholders of the SDE should establish mechanisms for risk management and compensation for potential damages to smallholders due to harmful unintended consequences of data collection, analysis, or selling (Mc Donald, 2019).

Finally, the context matters in applying fair data governance practices in the SDE, which is true for all the proposed data governance principles. Interpretations of the principles should therefore account for the different values held by the respective stakeholders.

Privacy, too, should be perceived in an inclusive sense in smallholder-oriented data governance. Interpretations of privacy should therefore reflect not only the conceptual or legal tradition of well-resourced stakeholders or only focus on the individual nature of rights (United Nations, 2018) but also draw from frameworks, interpretations, and traditions smallholders are more familiar with in their local context (Gehl Sampath & Tregenna, 2022). In practice, for example, in particular African contexts, this could mean that the communal nature of African communities should be considered, such as the concept of Ubuntu<sup>8</sup> (Gehl Sampath & Tregenna, 2022; Olinger et al., 2007; Razzano, 2020).

Therefore, from the principle of legitimate expectations for privacy and security follows that smallholder-oriented data governance should also comprise the following enabling conditions:

5. Clear rules for data collection and processing exist in the data governance arrangement.
6. A monitoring and enforcement mechanism for the established rules can identify and protect the sensitive data of smallholders.
7. Mechanisms for risk management and compensation are implemented.

### 3.4 Provision of Practical Necessities

The literature review uncovered that smallholders face a range of practical challenges that obstruct their ability to engage in the governance of their data, such as digital illiteracy or the lack of information and means of communicating it in their native languages (Miller et al., 2013). Thus, the availability of data technology infrastructures and tools does not guarantee accessibility and understanding (Msengezi, 2019). Operability and access to infrastructure, however, are prerequisites to participating in fair data governance. Therefore, the stakeholders must be aware that there is no one-size-fits-all approach for smallholder-oriented data governance. In constructing rules and policies for fair data governance with smallholders, the existing local context and culture should be reflected in the stakeholders' interactions. Essentially, the goal of smallholder-oriented data governance should be to arrange the necessary practical conditions that allow smallholders to engage in the governance of their data and empower them to become data controllers. Hence, access to essential infrastructures such as ICTs is necessary to support vulnerable communities in the digital transformation process of the agricultural sector in the Global South to gain sovereignty over their data and self-determination (Couture & Toupin, 2019).

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<sup>8</sup> Ubuntu is "(...) an ancient African worldview based on the values of intense humanness, caring, respect, compassion, and associated values ensuring a happy and qualitative human community life in a spirit of family" (Olinger et al., 2007, p.33).

However, digital literacy, besides literacy itself, is one of the biggest challenges to data governance for Sustainable Development in rural areas where frustration and reduced enthusiasm about new technologies can spread quickly (World Bank, 2017). Many smallholders will become new users in the future. Education increases accessibility and confidence in using data-driven tools and is, therefore, key to empowerment in smallholder-oriented data governance. Education also involves conveying an understanding of the risks and benefits linked to participating in data-driven agriculture and data governance, as well as raising awareness of data as a tradable commodity.

Knowledge facilitation is, hence, an essential building block for the genuine self-determination of smallholders in respect of fair data governance. However, since smallholders do not have the resources to lead the process themselves, better-resourced stakeholders should provide feasible means for smallholders to obtain relevant information, training, and access to essential infrastructures.

The presence of the principle of provision of practical necessities can hence be determined if a governance arrangement ensures that:

8. The necessary practical conditions are fulfilled that enable smallholders to engage in the governance of their data.
9. Smallholders have meaningful access to relevant information, education, and continuous learning.

### 3.5 Transparent and Deliberate Decision-making

Smallholders are not always given appropriate recognition or compensation for sharing their information and knowledge. In some instances, smallholders are not informed about data collected about their farms. For example, few know that some equipment collects and transmits data to central databases elsewhere. Moreover, when farmers know about data collection from their farms, they are not well informed about its extended use (Ferris & Rahman, 2016). Therefore, when constructing smallholder-oriented data governance arrangements, the stakeholders must anticipate challenges and acknowledge possible conflicting interests due to stakeholders' varying capabilities and limitations (Mc Donald, 2021). Consequently, it is essential to establish transparent mechanisms for deliberate decision-making and conflict resolution to prevent exploitative behavior and mitigate unintended negative consequences of the asymmetric distribution of power and access to resources within the governance system.

All the essential information regarding the purpose of data collection, intended use, and which stakeholders will have access to smallholders' data should be made available and accessible to smallholders to build trust by transparency. Furthermore, smallholders should be given sufficient time and opportunities to make a deliberate decision.

Furthermore, impartiality and openness of decision-making processes are crucial to transparency in fair data governance. Therefore, smallholders must have meaningful access to decision-making processes at all stages that establish rules for the stakeholders of the SDE. Participation of smallholders in decision-making processes, hence, could ensure that the privileged position of better-resourced stakeholders in the SDE leads to an unbalanced representation of interests towards a particular stakeholder. Meaningful participation of smallholders and consensus-oriented decision-making can thus be a means to resolve possible encountered conflicts (Gehl Sampath & Tregenna, 2022; Girard, 2019).

The following enabling condition can hence be an indicator of the presence of transparent and deliberate decision-making in smallholder-oriented data governance:

10. The data governance arrangement establishes a transparent mechanism for deliberate decision-making and conflict resolution.

### 3.6 Discussion and recommendations

This research project aimed to uncover the attributes of fair data governance in data-driven smallholder agriculture and to consolidate these attributes in a set of principles. To fulfill this objective, the thesis answered the following research questions:

- I. *How and to what extent does smallholder-oriented data governance contribute to sustainable smallholder agriculture and subsequently to Sustainable Development?*

The thesis outlined that fair governance of smallholder's data could have a significant impact on smallholder's well-being (Farmer Income Lab, 2022; The Living Income, 2021) and Sustainable Development (Bayer et al., 2018; Kamara et al., 2019; United Nations, 2014) since agricultural data has become a valuable resource (Gillwald et al., 2018; Gray et al., 2018; Maru et al., 2018; Mehrabi et al., 2021; Miller et al., 2013; Tsan et al., 2019; Wekesa et al., 2017). The literature review, however, discussed that the value derived from smallholders' data and its fair governance is difficult to measure (Jouanrjean et al., 2020).

Nevertheless, this thesis also described various approaches to capitalize on the value of data vis-à-vis sustainable smallholder agriculture and Sustainable Development. Fair data governance, e.g., could help to bridge the 'digital divide' (H. Brouwers, personal communication, August 4, 2022), reduce poverty (SDG1) (Jha et al., 2016), contribute to food and nutrition security (SDG2) (FAO, 2022; Jellema et al., 2015), or improve smallholders position in global agricultural value chains (SDG8), (SDG10) (Farmer Income Lab, 2022; Miller et al., 2013; Solidaridad, 2022; The Living Income, 2021).

- II. *What is the contemporary understanding of data governance, digital sovereignty, and fairness in the smallholder data ecosystem?*

The concepts of data governance and digital sovereignty were identified as key concepts for developing smallholder-oriented data governance principles and for conceptualizing the notion of fairness in the context of this thesis. This thesis argued that data governance is concerned with creating conditions for organized collective action among public and private stakeholders and individuals in the SDE. A central characteristic of governance principles is that rules that govern the interactions of the SDE are not imposed but result from inclusive policymaking (De Beer, 2016; Khatri & Brown, 2010; Mc Donald, 2021; Sharp et al., 2022).

However, the problem statement also outlined fundamental challenges and ambiguity about the implications of the notions of data governance and digital sovereignty in the context of smallholder-oriented data-driven agriculture. An essential challenge that should be addressed by a fair governance arrangement of stakeholders in the SDE is the asymmetry of power and information among stakeholders. Unequal accessibility of essential infrastructures and knowledge poses a significant challenge to smallholders to take well-informed and sovereign decisions (H. Brouwers, personal communication, August 4, 2022; GFAR, 2018b; Jouanrjean et al., 2020; Mc Donald, 2019).

Furthermore, the notion of fairness was conceptualized in the context of data-driven smallholder agriculture and contrasted with the concept of digital sovereignty. Four fundamental criteria derived from the analysis of academic and gray literature (accountability, transparency, empowerment, and harm avoidance) were attributed to the notion of fairness in data-driven smallholder data governance in this thesis. These criteria later guided the development of the final set of principles. However, this thesis also argued that the concept of informed consent and digital sovereignty are challenges regarding fairness in smallholder data governance since inducing informed consent from smallholders that satisfies fundamental criteria such as accountability, transparency, or empowerment, is an essential challenge in the SDE where there is no certainty in the available knowledge due to its normativity (H. Brouwers, personal communication, August 4, 2022; Chaves Posada, 2014; Fisher & Streinz, 2021; M. Nkomo, personal communication, August 4, 2022; Viljoen, 2021; C. Witkowski, personal communication, 2022). Conclusively, the empowerment of smallholders to digital self-determination is an aspiration of fair data governance in data-driven smallholder agriculture, as outlined in the proposed principles. However, in the SDE, discussed challenges such as the accessibility of essential infrastructures must be overcome to establish smallholder-oriented data governance practices.

### *III. Which attributes make for smallholder-oriented data governance in data-driven smallholder agriculture?*

To answer the central research question of this thesis, a set of five general principles and ten enabling conditions were developed. The following section discusses some challenges that could be encountered in practice and recommends how stakeholders could balance these challenges.

Ethical Professionalism, e.g., relies mainly on the voluntary commitment of better-resourced stakeholders to take responsibility where they might not be obliged by law (Makulilo, 2015). The literature review and the stakeholder and practitioner feedback suggested a general appreciation of stakeholders for clarifying standards for fairness in data governance in data-driven smallholder agriculture (H. Brouwers, personal communication, August 4, 2022; M. Nkomo, personal communication, August 4, 2022; Scheyvens et al., 2016; E. Van de Ven, personal communication, August 4, 2022; C. Witkowski, personal communication, 2022). However, principles alone cannot ensure that some stakeholders will not attempt to exploit their privileged position at the expense of smallholders and Sustainable Development (Girard, 2019; Mc Donald, 2019, 2021). Therefore, it is also up to governmental decision-makers to develop legislation that requires stakeholders in the SDE to be accountable when they engage in value exchanges with smallholders' data. Irrespective of their role in the SDE (data generators, controllers, or intermediary). All stakeholders should be accountable to ensure smallholder-oriented data governance.

In practice, Sustainable Benefit Sharing is challenging to determine because the value of data can be expressed in many ways (H. Brouwers, personal communication, August 4, 2022; De Beer, 2016; Sharp et al., 2022; Solidaridad, 2022). Furthermore, stakeholders also have different perceptions of what a sustainable value exchange for data entails. However, generally, this thesis argued that there is a high potential for sustainable benefit sharing if all stakeholders benefit from value exchanges of smallholders' data in some way and if the data flows are transparent and equitable. For instance, when smallholders receive refined data that is relevant to them from other stakeholders (GFAR, 2018b).

Furthermore, concerning the central research question, stakeholders showed to be far from agreement on the values at stake. Some stakeholders, for instance, argue that smallholders data only becomes valuable when it becomes aggregated, and since data collection is associated with significant costs for the data collector, the collecting and refining stakeholder (which are usually the well-resourced stakeholders of the SDE) should also be allowed to keep the derived financial benefits from their work (H. Brouwers, personal communication, August 4, 2022; FSD, 2022b; E. Van de Ven, personal communication, August 4, 2022). However, this thesis argued that to attain Sustainable Benefit Sharing, data collectors cannot have the benefits on their own. A question then arises on how much compensation is sufficient to be fair to the stakeholders involved in value exchanges of smallholder data. Or in other words, how should the (financial) benefits derived from smallholders' data be allocated? This becomes especially relevant in instances where smallholders' data is collected, refined, and then monetized. Feedback received from the stakeholders and practitioners suggests that the underlying problem to this question is also

unstructured since stakeholders seem to have no agreement about involved values and a high degree of uncertainty in the available knowledge. Therefore, potential following research should examine the question of value allocation in more detail and reduce uncertainty in available knowledge in this regard.

Avoidance of harm is central to the principle of legitimate expectations of privacy and security, which requires proactive measures from the stakeholders. M. Nkomo (personal communication, August 4, 2022) argues that internal review panels are insufficient to guarantee that a particular value exchange for smallholder data is mutually beneficial. While codes of conduct for ethical behavior of organizations working with smallholders and their data are desirable, it is still better to "(...) get an independent group of people within the organization to evaluate the approach and make sure that it is doing no harm" (M. Nkomo, personal communication, August 4, 2022).

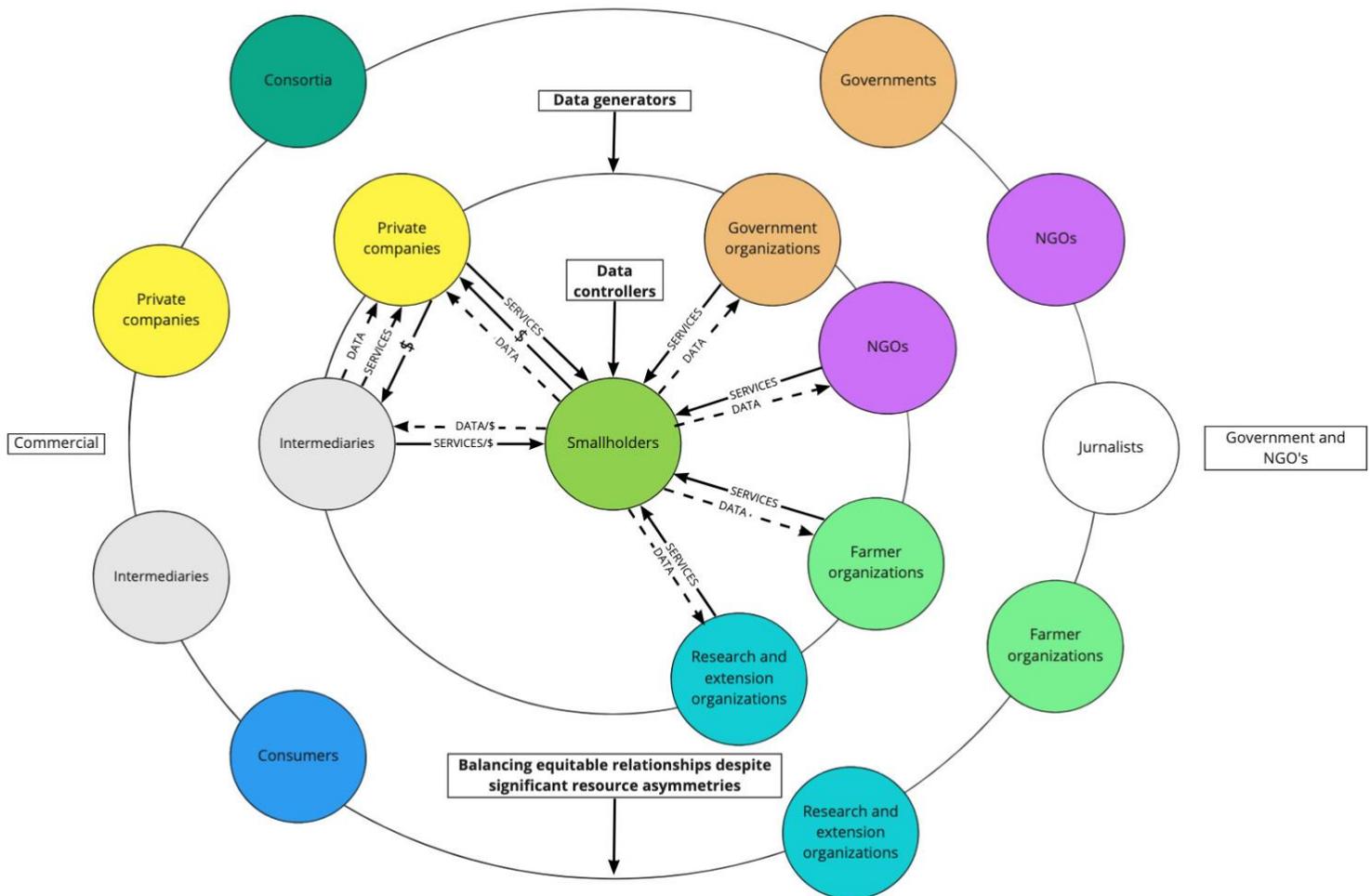
Transparent and deliberate decision-making requires reconsidering the allocation of roles between stakeholders, which could lead to conflict and considerable trade-offs. However, sharing responsibilities and participation of smallholders in decision-making could support the development of fair data governance policies. Furthermore, smallholders should be enabled by better-resourced stakeholders to become data controllers. This way, the power asymmetries could be more balanced. At the same time, better-resourced stakeholders cannot be expected to give up their privileged position in the SDE because of involved path dependencies. However, fair data governance policymaking is still in the early stages of development in the SDE, which can also be interpreted as an opportunity for the proposed principles since path dependencies have not yet materialized.

Furthermore, well-resourced stakeholders occupying both roles of data generators and data controllers contribute to the disparity in the SDE. Participation through the inclusion of smallholders in the decision-making process is a necessary condition without which fairness cannot be attained. But how much participation is sufficient? Arnstein (1969) contends that the mere availability of options to participate in decision-making would mean that smallholders are empowered. Essentially, that implies that "(...) participation without redistribution of power is an empty and frustrating process for the powerless" (Coghlan & Brydon-Miller, 2014, p.590). Consequently, better-resourced stakeholders of the SDE must establish mechanisms that guarantee smallholders the role of data controllers.

Furthermore, this thesis argued that the benefits of smallholder participation could be shared mutually. The involvement of smallholders can improve problem-solving and solutions for everyone because problem ownership is shared among all stakeholders (Scolbig et al., 2014). Additionally, sharing responsibilities through smallholder participation can facilitate mutual trust,

which is essential for sustainable value exchanges of data (Coghlan & Brydon-Miller, 2014; Sharp et al., 2022; Stalla-Bourdillon et al., 2020). Trust and transparency add to the legitimacy of decision-making as the individual perceptions of stakeholders of how a decision-making process was implemented are crucial and help to carry decisions even if some stakeholders might not agree with the final outcome (Coghlan & Brydon-Miller, 2014). Essentially, smallholder-oriented data governance could potentially be more effective with smallholders' participation because the means of enforcing rules are limited. However, M. Nkomo (personal communication, August 4, 2022) argued that third-party certification schemes for fair data governance should be considered in that regard. Figure 4 depicts a model of a functioning SDE balancing equitable relationships despite resource asymmetries by implementing the proposed framework for smallholder-oriented data governance.

Figure 4: Model of a functioning smallholder data ecosystem by balancing equitable relationships. Authors illustration.



The inner circle shows the smallholder data ecosystem, as explained in Figure 2. In contrast, the outer circle represents the stakeholders that could participate in the implementation of fair data governance practices based on the literature review and stakeholder and practitioner feedback. The previous paragraphs discussed the potential challenges in applying the proposed principles for smallholder-oriented data governance in data-driven smallholder agriculture and how they could be realized. The following section further outlines why the principles for fair data governance matter.

First, the principles should not be interpreted as fixed policies or a set of ‘commandments’ since they are formulated very broadly. Instead, stakeholders in smallholder data ecosystems could interpret the principles when they design policies. However, the principles could also be helpful for other stakeholders in data governance who are not directly involved in data-value exchanges with smallholders, such as consumers, journalists, and the general wider public (E. Van de Ven, personal communication, August 4, 2022). In that sense, the principles could be interpreted to extend the peer community to the broader public in the Global North and Global South. Hence, the stated enabling conditions could support the inclusivity of stakeholders, otherwise excluded from the SDE, and play a key role in checks and balances in smallholder-oriented data governance. This is because consumers or journalists can use the proposed principles as a tool that enables them to assess the fairness of governance arrangements in data-driven smallholder agriculture. In this way, the proposed principles could have a deterring effect on better-resourced stakeholders when they are under the scrutiny of consumers and journalists but also a motivating effect because “(...) people do not like to be taught what to do, but they do like to know what is right and wrong because they love judging each other” (E. Van de Ven, personal communication, August 4, 2022). Consequently, what E. Van de Ven (personal communication, August 4, 2022) infers, is that the principles and their enabling conditions could facilitate a race to the top regarding fair data governance among better-resourced stakeholders in the SDE.

However, stakeholders have different views on the implications of the proposed principles. Some emphasize the importance of pragmatic approaches and their relevance to design policies for practice. They argue that, e.g., the unsolved issues around informed consent do not imply that data governance arrangements in data-driven smallholder agriculture are unfair when not all conditions are perfectly fulfilled (H. Brouwers, personal communication, August 4, 2022; E. Van de Ven, personal communication, August 4, 2022). Others, however, argue that all enabling conditions must be satisfied in the smallholder data ecosystem for it to be considered a smallholder-oriented data governance arrangement (M. Nkomo, personal communication, August 4, 2022; C. Witkowski, personal communication, 2022).

Finally, the proposed principles fit well into the existing body of literature, particularly the existing approaches to responsible data governance in other contexts (AG Data Transparent, 2014; CGIAR, 2012; Cohen & Wendehorst, 2022; GFAR, 2018b; GO FAIR, 2016; RD, 2018; Waugaman, 2016; WFP, 2016). However, the distinct context and the discussed challenges associated with data-driven smallholder agriculture require a more nuanced approach to fairness in smallholder data governance. To facilitate the transition towards more equitable global value chains and value exchanges for smallholders' data, this thesis argues that both discussed approaches to smallholders' digital sovereignty are needed for smallholders to attain meaningful control and ownership over their data. Weak sovereignty in the form of private, sector-led initiatives should facilitate the proposed principles to ensure data protection and legitimate expectations of smallholders in the data economy. On the other hand, a strong sovereignty approach to ensure smallholders' interests in fair data governance relies on state-led initiatives through vigorous policymaking (Polatin-Reuben & Wright, 2014).

In summary, to answer the central research question 'which attributes make for smallholder-oriented data governance in data-driven smallholder agriculture?' this thesis research project identified four fundamental criteria associated with the concept of fairness in data governance (accountability, transparency, empowerment, and harm avoidance). These essential attributes should always be considered in assessing data governance arrangements in data-driven smallholder agriculture in terms of fairness. However, to conceptualize sustainable data governance in smallholder farming, this thesis uncovered, proposed, verified, and discussed five principles and their respective enabling conditions.

#### 4. Conclusion

This thesis project affirmed that the digital transformation in the agricultural sector has the potential to benefit smallholder farmers regarding Sustainable Development. However, the increased use of data-driven technologies encompasses the potential of significant unintended consequences such as shifting benefits disproportionately to those stakeholders with power and resources, such as dominant companies in the global food industry, international financial institutions, or agricultural service providers. Therefore, this thesis reflected on this development by successfully exploring three research questions and answering them. The aims of this exploratory study were met by developing a set of general principles for smallholder-oriented data governance in data-driven smallholder agriculture.

Exploring this research topic uncovered the relevance of ethical, value-based considerations for decision-making when investigating the effects of transformation processes. Conventional, linear models of science may not provide salient explanations regarding fairness in data-driven smallholder agriculture because of the discussed system uncertainties, decision stakes, and potential trade-offs (Funtowicz & Ravetz, 1993; Kates et al., 2001). Consequently, scientists investigating the interdependencies of complex and dynamic systems such as the smallholder data ecosystem should consider post-normal science approaches in their epistemology. Finally, more research still needs to be done to investigate explicitly the perspectives of the different stakeholders in the SDE, especially the smallholder farmers.

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