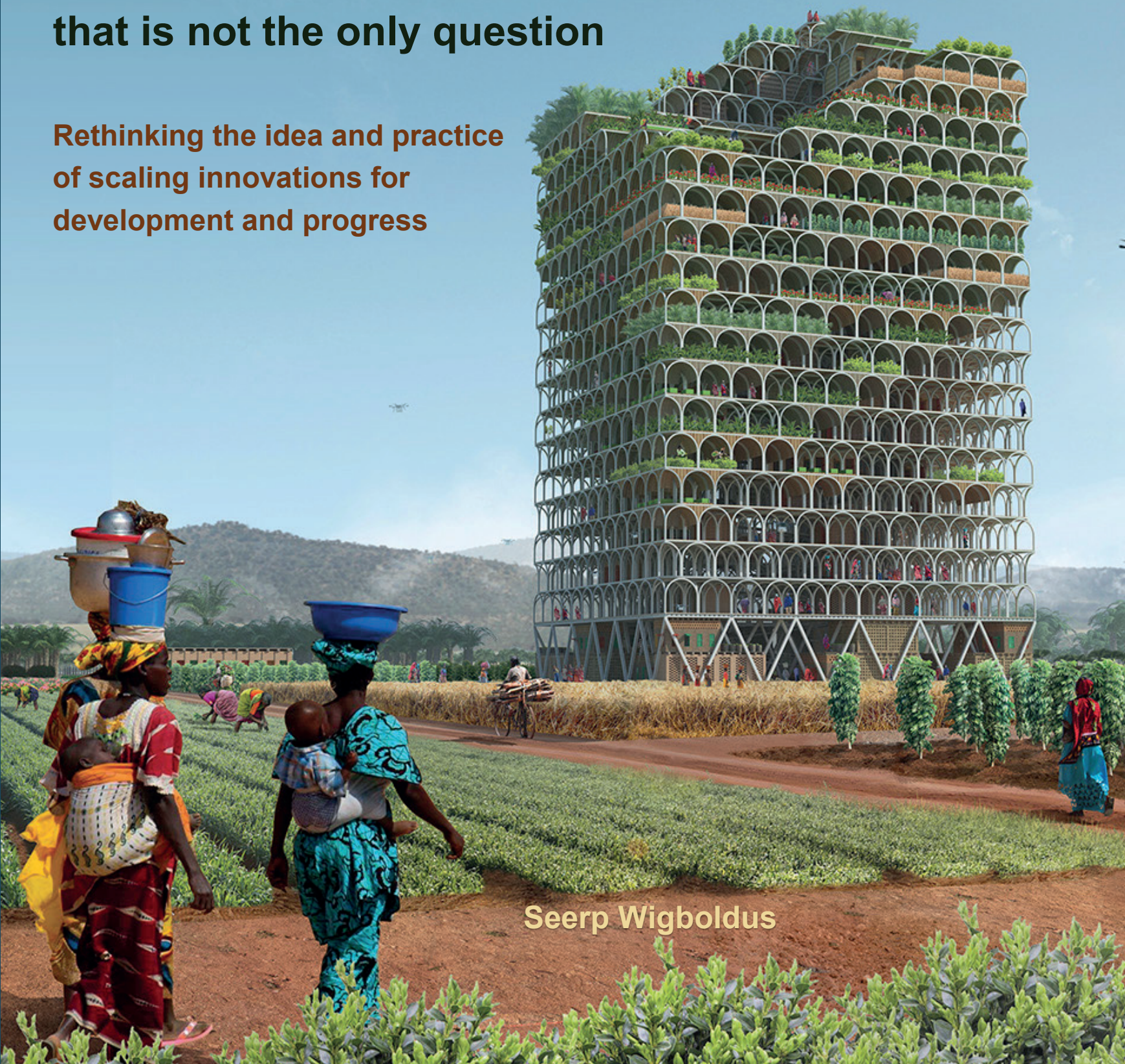
To scale, or not to scale – that is not the only question

Rethinking the idea and practice of scaling innovations for development and progress



Seerp Wigboldus

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Thesis

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Finally, the literature that I read while working on this thesis left me with a deep sense of both appreciation for well-articulated and well-presented arguments, and modesty because I realise that this thesis is just one contribution in a vast body of literature on innovation, scaling, and associated ideas and ideologies in society.

Wageningen, July 2018,

Seerp Wigboldus

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CHAPTER 1

Introduction

1.1 General introduction

The term 'scaling'[1] has become increasingly popular over the past three decades in the context of development initiatives and related investment proposals. The object of such scaling is often generalised as 'innovations' as a *pars pro toto* that includes (new) technologies, practices and habits, policies and wider institutions, and projects. Such innovations are generally considered to be a response – often framed as a 'solution' – to societal challenges. Why this popularity, what ideas and practices are behind the use of this term, and are there any critical implications to be considered? These were the initial questions that sparked my interest in the topic area. The term is used widely in different (scientific) contexts involving different interpretations and applications (Wigboldus & Leeuwis, 2013). In this thesis, I specifically focus on how it features in the context of initiatives that are meant to contribute to what is generally framed as 'development' and 'progress', including related development goals such as the Sustainable Development Goals (SDGs). Within this focus, I pay particular attention to processes of agricultural development and innovation. This introductory chapter describes the topic area, positions the thesis in ongoing discussions and debates, discusses the knowledge gaps addressed by the thesis and the type of critical approach followed, and outlines how an initial literature study and emerging hypotheses were translated into a research project.

Section 1.2 describes the essence of this thesis. Section 1.3 provides a brief historical perspective on the use of the term scaling in the context of scaling innovations for development and progress. Section 1.4 provides a more specific background regarding the concepts of scale and scaling and the application of these concepts, to show how the specific focus of this thesis sits within a wider usage of the term and concept, thus clarifying the focus of the study. Section 1.5 further expands on the motivation for, and purpose of, this thesis: why I consider it important to rethink the idea and practice of scaling innovations for development and progress, and what I aim to contribute through this thesis. Finally, section 1.6 presents the research questions and the related research methodology.

1.2 This thesis

In the context of agricultural development and innovation as well as in international development more generally, the use of the term scaling has increased significantly over the past 20–30 years (Wigboldus & Leeuwis, 2013). Such use often refers to an aspired transition from limited application of particular innovative products,

[1] Often also phrased as scaling up or scaling out. Scaling up involves moving up on a particular scale, such as the application of particular new practices. Scaling out usually refers to wider (geographically) application. These terms are discussed in more detail later in this thesis. In this chapter, we use the generic 'scaling' unless quoted literature phrases it differently.

practices, and projects to significantly wider use or application of the same. The outcome is then expected to be the multiplication of benefits (often phrased as impact at scale) (e.g. see Little, 2011, 2012) associated with the innovations during initial application (often called a pilot). The underlying reasoning is that, if something provided benefits when applied on a small scale, it will provide even more benefits when applied more widely. This reasoning is often taken to a next level, such as in the following statement: "to have significant impact on poverty and food security requires a massive scale up of (…) emerging examples"[2]. In a similar way, former president Bill Clinton noted that "nearly every problem has been solved by someone somewhere. The frustration is that we can't seem to replicate [those solutions] anywhere else" (quoted by Olson, 1994). Ezilov (2011:24) further states that "in order to be able to address the problems facing the development world, scaling up must be brought to the forefront of development rhetoric and action". I concluded that scaling of (specific) innovations is presented by many as a key mechanism and model for achieving societal goals.

This perspective and its alleged promise is shared widely from left to right, from progressive to conservative, and from business to science. Almost everywhere, the idea and the alleged promise of scaling innovations go largely unchallenged as long as an appreciated innovation is involved. The outcomes of scaling innovations have been critiqued by many (e.g. in relation to processes of commercialisation, technologisation, industrialisation, as by e.g. Babu & Sanyal, 2009; Daño, 2014; Hendrickson & James, 2005). These critiques, however, rarely elaborate on the related processes of scaling innovations as such. Also, many have discussed how best to scale (up) innovations (notably by Cooley & Kohl, 2006, 2016; Jonasova & Cooke, 2012; WHO, 2009, 2010, 2011). However, again, the process of scaling as such and related potential negative implications are rarely discussed critically. After all, who can be against the wider application and use of something that is considered to be good?! It appears to be a compelling reasoning that, if we find the best innovations and see those applied and used more widely ('scaled up'), we could solve many of the world's grand challenges. The underlying rationale is that, if good innovations lead to good progress, then the scaling of good innovations leads to more good progress. The popular idea of scaling innovations therefore expresses a (re)new(ed) sense that 'we can do it': we can eradicate severe poverty, we can achieve food and nutrition security for all, and so on… if only we scale (up) the best innovations, in a situation where there is, of course, a variety of preferences as to what exactly would need to go to scale (e.g. Chandy et al. 2012; Cooley & Kohl, 2006; Gradl & Jenkins, 2011; Pachico & Fujisaka, 2004). Given the benefits of scaling the use and application of innovations such as vaccines and medicines, of devices such as cars and mobile phones, and of agricultural

[2] Bas Rüter in the foreword to Woodhill et al. (2012).

innovations such as high-yielding varieties and more efficient production processes, there appears to be little reason to have second thoughts about the abovementioned reasoning.

It therefore does not come as a surprise that the majority of documented studies on strategies and policies for scaling (up) innovations in the wider context of international development focus almost exclusively on the question of 'how to make scaling of innovations happen' (e.g. Gaye & Nelson, 2009; Gillespie, 2004; Hartmann & Linn, 2008; Jonasova & Cooke, 2012; Linn, 2010/2011/2012, Middleton, 2003; WHO, 2009). IDRC (International Development Research Centre) recently developed a more critical approach along the lines of what they frame as 'scaling science' (Gargani and McLean, 2017) and it is only recently that I found groups like IDRC which start to ask questions beyond 'how to make scaling happen'. As mentioned above, more generally, for example in relation to what some have framed as industrialised agriculture, there is a large body of critical literature. However, such literature rarely explores processes of scaling innovations specifically, focusing more on outcomes of such processes. In the literature that does focus on scaling innovations, once the case has been made for the potential usefulness of an innovation, no further questions appear to be asked when plans are presented for wider use and application through scaling.

So, my initial literature research suggested that viewing the scaling of innovations as a critical mechanism to achieve development and progress is widely shared, and therefore rarely criticised, and certainly not a subject of hot debate (Table 1.1). After an initial literature review (Wigboldus & Leeuwis, 2013) however, some serious concerns surfaced: 1) has not the scaling of innovations been a cause of some of the grand challenges that we are currently facing (including climate change), 2) why is there critical debate in relation to technologies and innovations, while the seemingly closely related scaling initiatives (i.e. efforts to scale innovations) receive little specific attention in such debate? Debates on large-scale vs. small-scale are rather common, but these debates focus more on outcomes than on the scaling processes that led to such outcomes. Since Schumpeter (1934) stated that innovation implies not only the introduction of new products but also the commercialisation of new combinations (i.e. scaling the same), innovation has generally been considered to include scaling processes related to innovations. However, I would tentatively argue that processes of generating innovations and processes of their wider use and application involve two distinctly

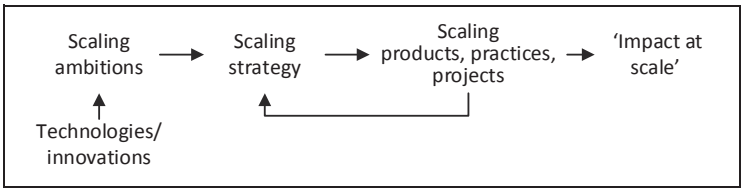
Table 1.1: Common motivations for scaling innovations

- Preventing situations of 'reinventing the wheel'
- Expected efficiency through economies of scale
- Saving R&D investments ('we already know what works')
- Being in a hurry to achieve set objectives ('no time to explore diverse pathways')
- Hesitance towards the unknown: use that which we know could in principle work rather than exploring/adapting new options that may bring something better, but we don't know

different types of dynamics, which are the dynamic of generating innovations and the dynamic of scaling innovations. Because the scaling of innovations is considered to be part and parcel of innovation processes, the implications of such scaling processes have, I would argue, not received appropriate attention in research. This also applies to the relevant perspectives on 'responsible innovation'. These perspectives have been gaining momentum, particularly in Europe (Stilgoe et al. 2013; van den Hoven et al. 2015), but rarely include specific deliberations of how scaling process could be changing the potential outcomes of innovations. It does not seem too far-fetched, however, to state that it makes a difference whether something is used or practised by few or by many and whether that is done in one particular locality or another (Menter et al. 2004) and that this difference also has implications for whether or not something can be considered responsible or appropriate. I therefore later argue for a need to articulate perspectives on responsible innovation *and responsible scaling*.

The generally uncritical attitude towards scaling innovations as an approach to achieve development and progress surprised me and appeared inappropriate given that many of the grand challenges faced by humanity are the effect of scaling innovations. This was what essentially motivated the research presented in this thesis. A conclusion emerging from the above considerations and questions was that, although scaling innovations for development and progress is commonly considered a 'no-brainer', it needs to be more critically assessed as a distinct dynamic in its own right (not merely a part of innovation processes); this has specific implications directly related to the nature of scaling processes. Such critical assessment would pertain to both the idea as such and to related (development) practice. My initial literature research (including reviews conducted by others, such as Ryan, 2004; Fixsen, 2009) demonstrated that hardly any literature seriously challenges the basic premises upon which the idea and practice of scaling innovations for development and progress are based. Figure 1.1 is a simplified representation of what I found to be the focus of the literature and of discussions on scaling innovations for development and progress.

Figure 1.1: The often-limited focus of literature on scaling innovations for development and progress – a simplified perspective

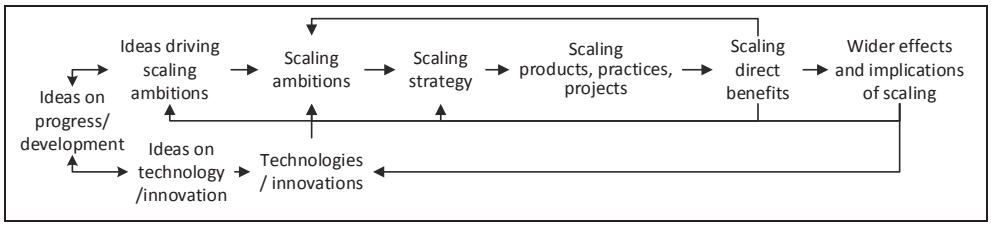


This picture represents the focus of relevant literature on 'making scaling work', not on critically assessing 'roots' (underpinning ideas and orientations about development and progress) and 'fruits' (long and short-term effects) of scaling approaches and strategies. It reflects an instrumentalist focus based on first loop learning (are we doing things right?) without involving much of second and third loop learning (are we doing the right things? are we thinking about

this in the right way?) (Argyris & Schön, 1996). Given the motivations for such instrumentalist focus, Ockeloen et al. (2012) explore ideas on increasing and decreasing scale in light of the fact that alleged economies of scale soon start to produce negative side effects, meaning that scaling leads to benefits only up to a rather low scale level. They conclude that extending benefits is in many cases not the main driver of scaling. Rather, it is motivated by an ambition to extend power, in which scaling becomes a strategic tool of e.g. the board to secure the position of a company or organisation in the market. Other motives include responding to a trend because scaling 'is in the air' and 'everybody is doing it', where benefits are assumed; the possibility of standardisation that scaling offers; and a response to external events and developments such as globalisation, privatisation, deregulation, available subsidies, and so on. Ockeloen et al. further conclude that the effects of increasing scale do not always align with motives: goals are often not at all, or even in a negative sense, achieved. They assert that scaling is often motivated by an opportunity to increase power and/or influence, with little concern for the interests of end users. In summary, their advice is therefore to critically approach the idea of scaling. They confirm that clear benefits can be achieved through scaling, but that it is definitely not a panacea. Similar voices are heard elsewhere, including in the context of international development and agricultural development specifically (e.g. Collier, 2007; Dichter, 2003; Easterly, 2007). These voices claim that it matters what goes to scale and what does not, who decides on this and who does not, and whose interests are served primarily in the process (Bloom & Ainsworth, 2010). In other words, an instrumentalist perspective on scaling innovations needs at least to be complemented by a critical perspective, if not critiqued as such.

Given considerations such as the above and given continuous debates and critiques on technology and innovation (e.g. Adibifar, 2016; Feenberg, 1996, Habermas, 1992; Hess, 2015; Hopper, 1991) I decided that a more holistic and critical perspective would be more appropriate than what commonly informs perspectives on scaling innovations (visualised in Figure 1.1) and that this would allow for a better inclusion of critical feedback loops in the idea and practice of scaling innovations for development and progress (Figure 1.2).

Figure 1.2: A simplified bigger-picture perspective on scaling innovations for development and progress



My initial exploration of issues related to the scaling innovations approach led to a number of questions to explore: What kind of thinking and philosophy underpins the idea and practice of scaling innovations for development and progress? Are the high expectations of this mechanism for development and progress warranted? What are the related theories of change? Successes have been claimed, but how serious are potential negative implications? What are the relevant areas of contention? Is there a need to apply guiding frameworks along similar lines as those adopted in relation to responsible innovation, to inform decision making and policy development on potentially negative implications of scaling innovations (e.g. as Stilgoe et al. 2013, have done for responsible innovation)? To what extent are development actors aware of how scaling processes sit in a wider context of other development processes and other perspectives on how change happens and/or is preferred to happen? What evaluative frameworks are used to assess the (long-term) outcomes of scaling innovations? We return to these questions in section 1.5.

These are the kinds of considerations that motivated me to embark on a study of the roots, practice, and fruits of the scaling innovations approach and associated strategies. The above explains the subject of this thesis. In the following sections, I further elaborate on the conceptual background against which the scaling innovations for development and progress approach needs to be understood to distinguish it from other usages of the term scaling (see section 1.4), and to further elaborate on key questions and concerns that motivated this study and the contribution it seeks to make (see section 1.6).

1.3 Historical background

The use of the term scaling in the context of scaling innovations for development and progress emerged in the 1980s (one of the earlier references being Myer, 1984). A number of processes influenced the rise of the popular usage of the term scaling in the context of scaling innovations. This is briefly explored in the following.

Originally, the term and concept of scaling was conceptualised in the natural and computer sciences (Fixsen, 2009) and also used in organisational settings. The use of the term scaling in the context of initiatives aiming to contribute to development and progress started only quite recently, in the 1980s. This was not the first reference to related processes, but they were mostly phrased differently before then, using words such as increase, expansion, and extension (Wigboldus et al. 2016).

NGOs were among the first to pick up the term towards the end of the 1980s and early 1990s when they were considering how to expand their impact in light of an observed lack of government capacity to address societal challenges appropriately (Uvin & Miller, 1994, 1996). This type of scaling related particularly to organisational scaling in

terms of growth in size, number, and capacity (e.g. number of activities) of organised (participatory) initiatives. It increasingly led to discussions regarding its potential impact on NGOs, e.g. in terms of being able to keep their strong links to the local, to remain participatory in nature, and to focus on impact at scale rather than just organisational size and expansion (Jowett & Dyer, 2012; Uvin & Miller, 1994; Uvin et al. 2000).

Another use of the term scaling emerged from a post-Cold War renewal of the idea of development and progress, with particular emphasis on the role of market forces, after disappointment in the idea of development as envisioned after WWII based on growth theory and led by government interventions. The Washington Consensus featured prominently in this renewed commitment to progress involving a move from state-led (with a brief intermezzo that focused on the role of NGOs) to market-led development and globalisation of development policy (Gore, 2000). Since then, cold water has been poured on enthusiasm for it because of its negative implications, leading to a rethinking of associated neoliberalism and global capitalist governance (e.g. Sheppard & Leitner, 2010).

Yet another origin can be found in the processes of global goal setting, first the Millennium Development Goals (MDGs), and then more recently the SDGs[3]. A goal, particularly when quantified, can be translated to a scale of moving towards such goals. The associated sense of urgency is matched well in popular communication with a terminology of scaling towards such goals. With quantitative goals that could be linked to quantitative (lower-level) targets and indicators, demands for evaluation, impact assessment, and results-based management became stronger. Increasingly, development efforts were asked to show contributions to such targets, especially in quantitative measures (e.g. Eyben, 2015; Eyben et al. 2015). This made framing programmes in terms of scaling innovations attractive because this allowed substantiation of its claims to impact at scale in relation to societal goals. The scaling innovations for development and progress (i.e. societal goals) approach helped to make the maths work in connecting development efforts to (quantitative) goal-related targets and indicators.

In the meantime, since the 1990s and especially since the 2000s, market-driven development has become more of a focus, involving increasing expectations that the private sector could help overcome limitations in achieving societal goals (Eklöf, 2014; Kharas, 2013). As development-related organisations (from research to public sector and NGOs) started to look more towards the private sector for help, business-development principles started to infuse development thinking. This implied that scaling innovations in the context of development programmes increasingly became

[3] https://www.un.org/sustainabledevelopment/sustainable-development-goals/

oriented towards an approach of 'selling' and marketing innovations (among which technologies are prominent). This is further explored in section 1.4.3.

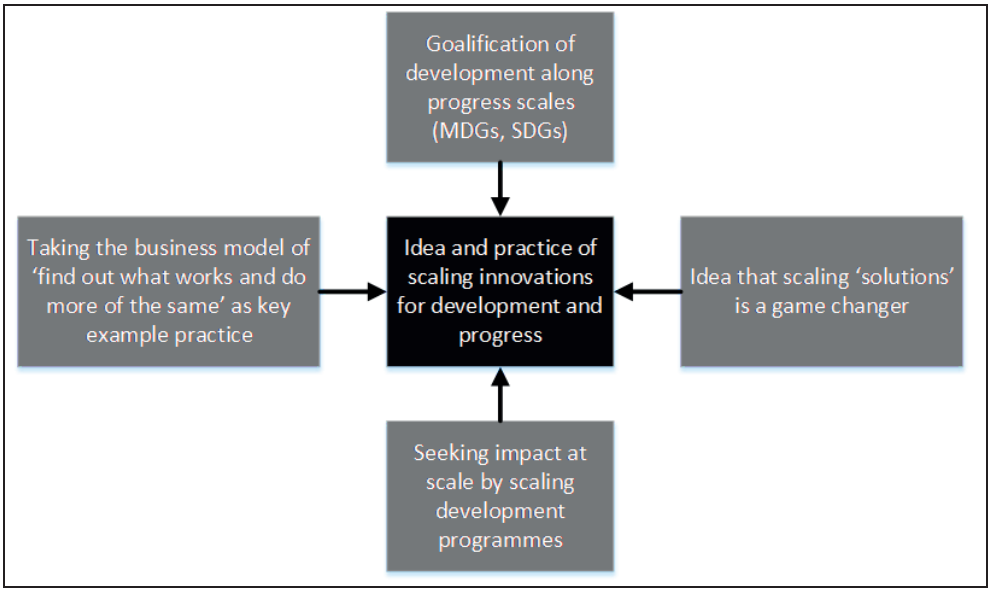
UNDP (2013) explores the evolution of the concept of scaling over the past few decades. It concludes that some old ideas returned (e.g. increased focus on controlling development processes, and I would add the blueprint approach), but also a new focus emerged in which the focus of scaling is becoming more directed towards impact (scaling impact) than on scaling projects or technologies. The scaling innovations approach takes desired impact as the point of departure and aims to scale that which leads to more impact (usually in the form of innovations). Project- or technology-focused scaling takes products and services as the point of departure and wants to see those go to scale, assuming that this will lead to desired impact. In later chapters, we conclude that a stated focus on impact at scale still tends to be all about scaling innovations. Although something new (innovation) may be put forward as a candidate for scaling, the scaling approach as such is generally left unchallenged.

During all this time, the concepts of scale and scaling were a key part of science (especially in mathematics and physics, see e.g. Barenblatt, 2003; West, 2017) but were largely used along quite different lines than in the context of scaling innovations for development and progress. However, around the same time as the term scaling became linked to innovations and achieving progress and development, the concept of scaling became more prominent in applied sciences, notably Geography (e.g. Brenner, 2001, MacKinnon, 2010; Smith, 2000) and Ecology (e.g. Wu & Li, 2006) although often in different ways of interpreting scaling. Their significant work in developing the use and utility of these concepts does not appear to have infused ideas on scaling innovations for development and progress very much but is becoming increasingly relevant, such as in relation to planetary boundaries (Ecology) and governance of scale (Padt et al. 2014) (Geography) and the merging of the two in e.g. ideas on a safe operating space for humanity (e.g. Raworth, 2017).

The above provides some background on different origins and roots of the popular reference to scaling innovations for development and progress. This does not provide a very precise picture of the history of the use of the term scaling in the context of development thinking and practice (see Figure 1.3), and I conclude that it represents a rather varied situation where different actors involved in scaling innovations will interpret scaling along rather different lines and use different narratives to support claims of its usefulness and effectiveness in achieving development and progress. The general idea of scaling innovations for development and progress has grown in popularity but relates to a mix of specific scaling concepts from different origins. We may characterise emerging approaches to scaling innovations for development and progress along the lines of the categories described by Subramanian et al. (2010). One category is about agendas of large global entities, who seek to go to scale with top-

down technical activities in pursuit of predefined global development goals, including the then MDGs and now the SDGs. The other category is about work focused on the specific process of scaling or rolling out demonstrably successful small-scale pilot interventions and transforming them into large programmes (Cooley & Kohl 2006; Simmons et al. 2007; Uvin, 2000). As mentioned earlier, NGOs have used the term scaling also in terms of increasing mobilisation, empowerment, and collective action at grassroots level (Binswanger & Atyar 2003). Bloom and Ainsworth (2010) summarise global narratives of scaling as being about 'doing more in a big way', communicating the need to increase the coverage of interventions or increase the resources required to expand coverage (Mangham & Hanson 2010; Subramanian et al. 2010). Such framing then supports calls for investments (by donors) to support the replication of externally validated, standardised interventions (Bloom & Ainsworth, 2010).

Figure 1.3: A perspective on main inspirations for the idea and practice of scaling innovations for development and progress



1.4 Conceptual background

The concepts of scale and scaling feature prominently in this thesis. However, the concepts are used more widely than only in relation to the focus of this study. This section therefore explores a variety of interpretations and applications in order to clarify the focus of study and distinguish it from other usages. As the wide variety of conceptualisations of scale and scaling are not the focus of this study, I discuss only some typical examples.

1.4.1 The concept of scale

Discussion of the term 'scale' could by itself easily fill up bookshelves and is also subject to intense debate. Almost anything can be expressed in terms of its scale (level) along the lines of a multitude of possible scales (in terms of yardsticks). The term is used to refer to many different things. Scale may, for example, be understood as size, scope, or magnitude. Some refer to this as scale in the ontological sense of the word. It can also be used to refer to a characteristic of something. Calling something a large-scale farm relates to a size-related characteristic of the farm. Another way of understanding scale relates to an ordered sequence or gradation used for measurement and comparison, where levels on a scale are arranged in a hierarchical way such that lower levels are part of more inclusive higher levels (Gibson et al. 2000; WUR, 2010). Some refer to this as scale in the epistemological sense of the word, and there is intense debate on this, especially in Geography (e.g. Chapura, 2009; Collinge, 2006). Debate notably revolves around the idea of a 'flat ontology', which challenges the appropriateness of speaking about hierarchical levels (scales) such as from local to global (e.g. Collinge, 2006). Finally, there is the meaning of scale in terms of ratio, such as a 1:100,000 map or a 1:25 scale model. This means that scale may relate to an actual size or scope of phenomena (which is independent of observers) and as a way of measuring or grading (which is used by observers) (Sayre & Vittorio, 2009).

Different interpretations of the concept of scale

Scale as a way of measuring or grading opens up the possibility of distinguishing an unlimited set of scales (in terms of measuring rods), depending on what one wants to measure (see Table 1.2 for examples from my study focus). A weighing scales is not much use for measuring size, and a speedometer (speed scale) is not much use for measuring weight. Understanding something appropriately therefore requires the use of appropriate scales. Even in weighing the same attribute (e.g. weight), it is important to use the appropriate scale (Sayre & Vittorio, 2009). Weighing envelopes to be sent in the mail requires a different scale than weighing a harvest of wheat from a field. As a result, we find different scientific disciplines, and different enterprises in general, using different scales for assessing that which is relevant for them. Physicists use different scales than sociologists, as they are trying to understand different types of patterns and processes. They share, however, the general method of using scales to be able to make distinctions between phenomena. Scales in this understanding are about analytical dimensions for measuring and studying phenomena where scale levels are about units of analysis located at different positions on a particular scale (Cash et al. 2006; Padt et al. 2014). Scales will often be arranged in a hierarchical way where lower levels are part of more inclusive higher levels (which may be visualised as a set of concentric circles with a small one in the centre and ever larger ones encompassing the earlier ones) (Gibson et al. 2000; Padt et al. 2014). This points to a difference

between scale as quality or size (e.g. area, velocity, weight) and scale as quantity or level (e.g. from small to big, or from local to global, which can be defined on an appropriate scale that serves as a measuring tool) (Sayre & Vittorio, 2009). Some confusion between users of the term originates from this difference. In the context of our study focus – scaling innovations for development and progress – both of these interpretations are at play, as explored in later chapters.

Table 1.2: Scales can be constructed along a multitude of different lines

In the context of scaling innovations, scale may be defined along the lines of different ways of ordering (adapted from Gillespie, 2004):
• Spatial scale levels: locality, landscape, region, globe
• Temporal scale levels: Daily, seasonal, annual, decades, centuries
• Jurisdictional scale levels: Local, municipal, regional, national, international
• Management scale levels: tasks, projects, programmes, organisation
• Economic scale levels: poor, medium-income, rich
• Social scale levels: individual, group, community, country
• Project scale levels: input, activity, output, outcome, impact
• Knowledge scale levels: from specific to general/universal

Scale framing

The concept of scale helps to interpret reality by distinguishing patterns and processes. Such orderings, however, are human constructs and are used to help organise our understanding of experienced reality and our work rather than pertaining to an objectively verifiable state of affairs. As scale is not an objective characteristic, scales can be used strategically as political devices (Padt et al. 2014; Swyngedouw, 1984). The way in which scale is framed then becomes a way of communicating to advance (political) agendas (van Lieshout et al. 2011). Scale framing relates to actors highlighting different (scale-related) aspects of a situation as a problem and situating this on different scales (van Lieshout et al. 2014). For example, something may be framed as a global concern, whereas others would consider it to be a local concern. Some refer to this as the interpretive moment of scale, to distinguish it from the ontological and epistemological understanding of scale. This perspective understands scale as a means by which scale difference and change is articulated, challenged, or defended (Rangan & Kull, 2009:35). Rangan and Kull (2009) explained how the interpretative moment of scale is produced by telling scalar narratives. A scalar narrative serves as a "device for political persuasion in the public realm, and plays a much larger role than rationality in the politics of governance" (:40). Through these narratives, an interpretative scale is produced, enabling political actors to exercise power or oppose authority in a way that appeals "to the emotions and sensibilities of the populace through the rhetorical shield of rationality and objectivity" (:40). The scale against which we measure affects how we understand things and how we

communicate such understanding. When something is defined as 'small', or 'playing at micro-level', or 'part of a periphery', it will carry particular connotations and influences how the object is approached by actors buying into such framing. Chapter 2 explores similar patterns in terms of 'scaling rhetoric'. In light of interpretations such as briefly explored in the above, Crawford (2009:35) concludes that "scale is not given but is produced through processes of social, economic, and political struggle for given historically and technologically contingent contexts".

Scale effects

Social and natural scientists alike acknowledge the importance of understanding scale effects and how relationships and processes operate differently at different scales (Evans et al. 2005). Wilbanks (2005:23) describes the understanding of relationships between macroscale and microscale processes and phenomena as one of the "grand queries" of science: "Many kinds of data pertinent to macroscale issues are gathered at specific points or in small areas, ranging from meteorological observations to crop production to soil samples". The challenges become even greater when "larger-scale characterizations are being constructed from incomplete local evidence (…), because so many critical driving forces – e.g., global climate dynamics, global population growth, global economic restructuring, and global technology portfolios – operate at very large scales but shape local realities and choices" (:23).

Towards a science of scale

In the context of Geography, Brenner (2001:593) expressed concern about stretching the term (geographical) scale so much that its "analytical power and theoretical potential (…) may ultimately be lost, causing scale to collapse into an overgeneralized 'chaotic conception'". A similar concern applies to the way in which scales are used in the context of scaling innovations for development and progress. Similarly, as Brenner (2001) expresses concern about the use of the term in the context of Geography, Wu and Li (2006) point to the need for ecologists to recognise the different usages of scale and scaling and the need to develop a way of consistently communicating about and between related methods in light of this. Given this need, they suggest developing a 'science of scale' that would enable this to be done. This could also be relevant for developing more comprehensive (including critical) perspectives on scaling innovations for development and progress.

I tentatively conclude that scale is a human construct that can be used and framed in ways to advance particular (political) agendas and that its use is therefore not necessarily neutral or objective. In scientific circles, it is used in quite different ways and is still very much the subject of discussion. This means that such conceptualisations and their use provide some understanding on which to build in

developing perspectives on scaling innovations for development and progress, but certainly not any conclusive reference.

1.4.2 The concept of scaling

The concept of scaling (verb) is, of course, closely related to the concept of scale (noun) but is more than just the active form of scale. As a verb, it may involve conscious human effort to scale (ranging from such activities as scaling a mountain or tower, to methodological processes in science, to changing the scale at which things are used or at which practices are performed); it may involve human activity that is not consciously aimed at scaling (e.g. scaling pollution, things 'going viral'); and it may refer to natural processes (e.g. scaling populations, scaling temperatures). Furthermore, related to the different meanings of scale, scaling may involve changing size, scope, or magnitude, or any other scale (in terms of measuring tool) used. Furthermore, scaling may be interpreted as keeping the proportions of a set of variables of the object of scaling the same, but it may also refer to the scaling of just one variable without the simultaneous scaling of other variables. To give a simple example of this: a tractor may be scaled as a scale model where all parts are made smaller or bigger, but scaling may also just involve the size of its wheels.

The concept of scaling across scientific disciplines

The difference between natural sciences and social sciences in relation to the concept of scale applies similarly to the process of scaling. In the natural sciences, the scaling process relates to verifiable properties of objects and phenomena. In Mathematics, it refers to an ordering in terms of numbers, dimensions, proportions, and so on. In Physics, it refers to an ordering in terms of speed of particles, size of particles, and so on. In Astronomy, it refers to an ordering in terms of universe, then galaxies, solar system, planet, and so on. In Biology, it refers to an ordering in terms of molecules, cells, organs, organisms, ecosystems, and so on. In Mathematics, there are scaling theories that relate to quite different processes than what we shall be discussing in relation to scaling innovations (see Chapter 6 for a further elaboration). In Biology, a theory of scaling refers to the search to find universal laws that rule proportions (between variables) in a process of scaling. For example, when an organism grows, its energy consumption will increase 0.75 times as fast (West & Brown, 2004). Recently, such theorising has been expanded in the context of Ecological Sociology[4] towards theories of scaling that cover everything from cells to civilisations and from citizen level to city level (West, 2017). The hypothesis proposes that scaling in forms of social organisation follows patterns that are similar to, or even the same as, patterns of scaling found in the natural world.

[4] Referring to theorising the relationship between the natural and the social.

In the natural sciences, scaling is typically about weight, distance, area, volume, velocity, duration, temperature, and other mathematical and physical phenomena. It is manifested in e.g. biological processes such as growth, multiplication, and mutation, and in physics processes such as gravity (when an object falls, its speed will scale according to a certain formula – a scaling, or power, law). In Physics and Biology, universal laws are described that govern how things scale up, reflecting underlying generic principles and mathematical patterns. These rather simple laws apply to almost every characteristic of living organisms, from individual cells all the way up to complex biological ecosystems (West, 1999). Scaling laws are the expression of physical principles in the mathematical language of homogeneous functions[5]. This notion of scaling has often been related to concepts such as self-similarity and fractals (Mandelbrot, 1977). Scaling (or power) laws are behind what causes things to grow proportionately. For most persons, arms and legs grow to the same length. The same kind of mechanisms also put a stop to growth at a certain point, for which reason there are few people taller than 2.2 metres. The universal character of these 'laws' led West (1999) to think that it is telling us something important about the way life is organised and the constraints under which it has evolved. Later in his career, he therefore started exploring the extent to which such scaling laws may also apply to processes like city development (Pumain, 2003; Rybski et al. 2009; West & Brown, 2004; West, 2017). Some 'social scaling laws' are in fact already acknowledged in such processes as traffic management, in predicting group behaviour when the number of group members increases, and in terms of memory capacity (how many faces we can remember) (e.g. Pumain, 2003; Rybski et al. 2009; West & Brown, 2004; West, 2017). This is a fascinating field of study, but not the focus of this thesis, so I shall leave it at this brief introduction. The potential relevance of such scaling laws seems not so much explored in the context of scaling innovations for development and progress (see Table 1.3 for relevant examples).

Scaling as an essential concept

Wu and Li (2006:11) conclude that "scaling is inevitable in research and practice whenever predictions need to be made at a scale that is different from the scale where data are acquired". "As scale changes, new patterns and processes may emerge, and controlling factors may shift even for the same phenomena. Thus, observations made at fine scales may miss important patterns and processes operating on broader scales" (:12). Scaling, in this interpretation, is about translating information between or across scales. Two kinds of scaling can be further distinguished: (1) scaling up or upscaling, which is translating information from finer scales to broader scales, and (2) scaling down or downscaling, which is translating information from broader scales to finer scales (Bierkens et al. 2001; Gardner et al. 2001). This concerns a specific interpretation

[5] http://www.scholarpedia.org/article/Scaling_laws, accessed 21 May 2013.

of scaling that is methodological in nature. Scaling here is about the relation between observations and applications at different scale levels. In modelling and making projections (scenarios), it is critical to understand this correctly (e.g. Biggs et al. 2007; Lehtonen et al. 2007; Tubiello & Fischer, 2007). Such understanding also appears to be critical in scaling innovations for development and progress, as in the process of scaling such innovations moves across different scales and different scale levels. Figure 1.4 illustrates two examples of different conceptualisations of scaling.

Table 1.3: Scale relationships – causally related scales

IFPRI's report on women in agriculture showed the importance of broadening perspectives on causal relationships to see how different scaling processes are connected and can be taken advantage of (IFPRI, 2000). They sum up the benefits of focusing on women as the key to raising agricultural productivity and food security, which translate to the language of scaling in the following two examples: • Agricultural productivity scales up dramatically when women's access to inputs is the same as men's. • Scaling women's education and status within the household contributes more than 50 percent to the scaling down of child malnutrition.

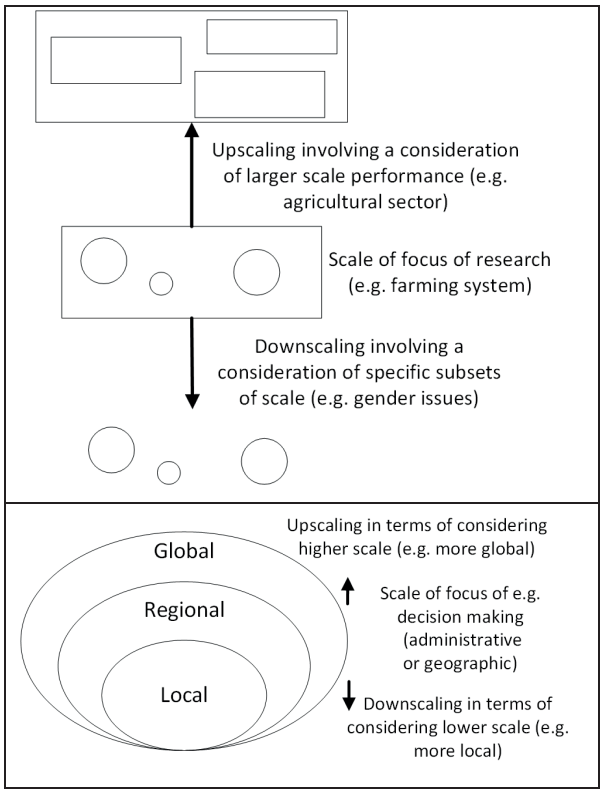
The concept of scaling is also used widely outside the context of science. First of all, it is part of common language in which it is often used in a basic meaning where scaling involves expansion or increase (e.g. operations that are scaled up) and where scaling down involves reduction or diminution (e.g. food waste, which is meant to be scaled down). In the context of security and safety concerns, scaling up or down relates to predefined scales in relation to required responses and preparations. In the business world, scaling is almost always about scaling up, where scale and scaling is almost equivalent to sales and selling. It may refer to such processes as franchising, taking a product or service to more markets, increasing market share, and expanding production and/or operations (e.g. Hofheinz, 2016). The focus is then on private goods, so the focus of attention is to make scaling happen, and not so much on implications for (global) public goods.

Between scientific and intuitive (everyday) use of the term scaling

The terms growth and scaling are often used interchangeably, pointing to a more intuitive use of the term, being much less precise and specific than how it is used in science. It tends to focus on technical and economic dimensions of innovations more than on social concerns. In the public sector, scaling will often tend to relate more to societal goals, usually relating to social wealth, such as health, security (e.g. food, financial, energy), and (social) protection. For example, scaling health service innovations is then meant to serve a higher goal of e.g. effective health services from a patient's viewpoint. Or scaling the use of electric cars, solar panels, and windmills may be subsidised in order to make energy production and use more sustainable. The

desirability and success of such processes will be assessed against that backdrop. Although the business sector plays a part in moving towards such societal goals through its scaling of production and marketing, businesses will generally measure success for themselves by sales performance and profits. There are examples of serious reconsiderations of scaling in the context of the business enterprise. In a chapter titled 'Rebooting the Scale Debate', Elkington et al. (2009) argue that it is time to work on practical tools ('no black box recipes') to guide scaling processes. They argue that such a search should be informed by what they call an ecosystems approach rather than from an individual enterprise perspective. The reason for this is that they aim for systemic change where interconnectedness, networks, alliances, and collective leadership are essential.

Figure 1.4: Illustrating two examples of different conceptualisations of scaling (in research processes and in Geography)



For the moment, I conclude that there is no clear consensus, in any field, on the operational meaning of the term 'scaling' (Bloom & Ainsworth, 2010; Cooley & Kohl 2006; Subramanian et al. 2011). As noted earlier, many discussions settle on a broad definition that simply indicates 'doing something in a big way to improve some aspect of a population's health' (Bloom & Ainsworth, 2010). "The idea of 'scaling' or 'scaling up' is increasingly the dominant framing for how success is understood (...). For many in the social sector, scale is a kind of Holy Grail" (Bradach, 2010:1). "There may be no idea with greater currency in the social sector than 'scaling what works'" (:1). So, scaling is a concept that is widely used across society, takes on very specific meanings in scientific study, and is further conceptualised in different directions according to the needs of particular disciplines. Although there is a certain measure of overlap with such elaborations of the concept, quite different conceptualisations are used in the scaling for development and progress approach. In the following section, I further

identify ways in which the concept of scaling is used in the context of development and innovation to clarify the focus of study of this thesis and to distinguish it from usages explored in this current section.

1.4.3 Scaling innovations for development and progress

The concepts of scale and scaling more generally having been explored, this section zooms in on conceptualisations of scaling in light of the focus of this thesis: scaling innovations for development and progress. It further expands on the brief history of scaling innovations approach as discussed in section 1.3. In this context, scaling is specifically about the wider use and application of innovations as part of goals and objectives such as food security or sustainable development. Other interpretations of the term remain relevant though, as noted in the above, because they may be useful for unpacking dimensions and dynamics of scaling that tend to be neglected in common approaches to scaling innovations for development and progress. We understand innovations not in a strict sense, but rather loosely as something considered attractive to use/apply that has not been considered for use/application before. There will be cases where it is not about something completely new, and, of course, what is an innovation for one group may already be a tradition for another group (Johannesen et al. 2001). Innovations, in this understanding, are not limited to technical innovations.

Conceptualisations of scaling innovations for development and progress appear to align more closely with common, more basic and intuitive interpretations of scale and scaling, in which scaling up is, simply put, about expanding (in whatever direction) and scaling down is about diminishing and reducing. In other words, the 'up' and the 'down' are about movements on a particular measurement scale.

The scaling innovations approach involves a management strategy (practical and managerial processes to help innovations go to scale), but also a particular type of thinking about 'how change happens' (i.e. theories of change), about 'how change ought to happen' (i.e. teleologies of change), and about what innovation and scaling processes are considered appropriate in light of related purpose orientations. Such purpose orientations may, for example, be economic (it is more efficient/cheaper at scale), technical (it works better at scale), or strategic (it has more impact at scale).

An exploration of the use of the term scaling in the context of international development (Wigboldus & Leeuwis, 2013) demonstrated the diversity of interpretations (Anderson, 2012). DFID defines scaling up as "identifying the most effective ways of channelling additional resources in order to achieve maximum impact on the MDGs" (DFID, 2013). The World Bank, in assessing scaling up in agriculture, defined the process as "to efficiently increase the socioeconomic impact

from a small to a large scale of coverage" (World Bank, 2003:x). The World Bank also argues that scaling up involves both means (for example, replication, spread, or adaptation of techniques, ideas, approaches, and concepts) and ends (that is, increased scale of impact) (Anderson, 2012). Cooley and Kohl (2006) avoid a definition, simply noting that scaling up "involves several distinct strategies including: the dissemination of a new technique, prototype product, or process innovation; 'growing' an organization to a new level; and translating a small-scale initiative into a government policy" (Cooley & Kohl, 2006:6). Hartmann and Linn (2008:5), the International Fund for Agriculture Development (IFAD) (IFAD, 2011:123), and Chandy and Linn (2011:1) define scaling up as "the expansion, replication, adaption and sustaining of successful policies and programs in space and over time to reach a greater number of people". ExpandNet (2011) defines scaling up as the process of reaching larger numbers of a target audience in a broader geographic area by institutionalising effective programmes. Table 1.4 provides a brief overview of the variety of subjects to which the concept (and practice) of scaling is applied.

Table 1.4: Application contexts of the scaling concept

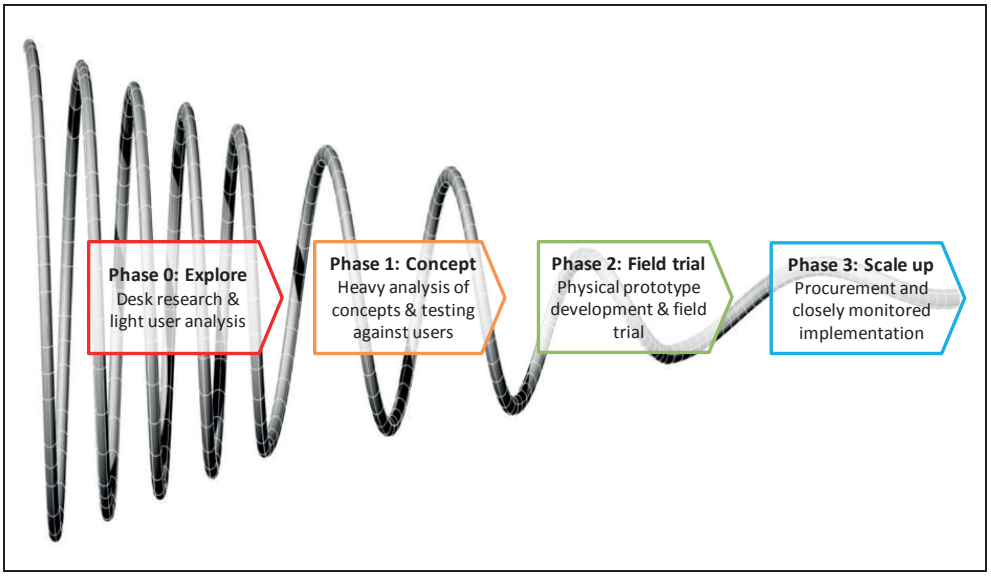
The concept of scaling has been applied to a wide variety of contexts and subject matters, including:
Scaling microenterprise services (Edgcomb, 2002)
Scaling the adoption and use of agricultural innovations (USAID, 2014)
Scaling agricultural innovation (Ogunniyi et al. 2017)
Scaling community-driven development (Gillespie, 2004)
Scaling forest-friendly finance (Oakes et al. 2012)
Scaling inclusive agri-food markets (Woodhill et al. 2012) or inclusion as such (Jenkins et al. 2010)
Scaling the Millennium Development Goals (WHO, 2010)
Scaling global food security and sustainable agriculture (Power et al. 2012)
Scaling innovative approaches (Moriarty et al. 2005)
Scaling democracy (Johnson, 2014)

The overriding interpretation of scaling appears to be along the lines of linear development processes, sometimes framed as 'pathways to scale'. We find this as the main approach at the World Bank (Jonasova & Cooke, 2012), IFAD (Hartmann et al. 2013), WHO (2010), and several other international organisations. The essential idea behind this approach is expressed by Koh et al. (2012) in their study titled *From Blueprint to Scale*, in which they propose an approach of finding blueprints, validating them, preparing for scaling, and then scaling up. This perspective drives a strategy of finding ways of moving from pilot to scale, which proves to be very challenging in many situations. Creech (2008:9) therefore concludes that "the scaling-up process requires a tremendous amount of negotiation, diplomacy, patience, flexibility, time and resources to be successful".

Linn (2012) acknowledges variety in types of scaling up processes. Nevertheless, he emphasises the importance of concerted efforts to prevent everyone from scaling their own pilot projects. Scaling is about ensuring the quality of a development impact, reaching out to those left behind, and ensuring the sustainability and adaptability of

results. It is not about just replicating successes to cover larger groups or populations, and Linn (2012:7) maintains that "scaling up depends on successfully designed and implemented pilots, as well as political and fiscal space that is available for wider institutionalization of results". This involves an approach that may be summarised as a research-to-practice continuum involving three phases: pilot, scaling, and large-scale implementation (Fixsen et al. 2013; Passioura, 2010). Figure 1.5 visualises this perspective.

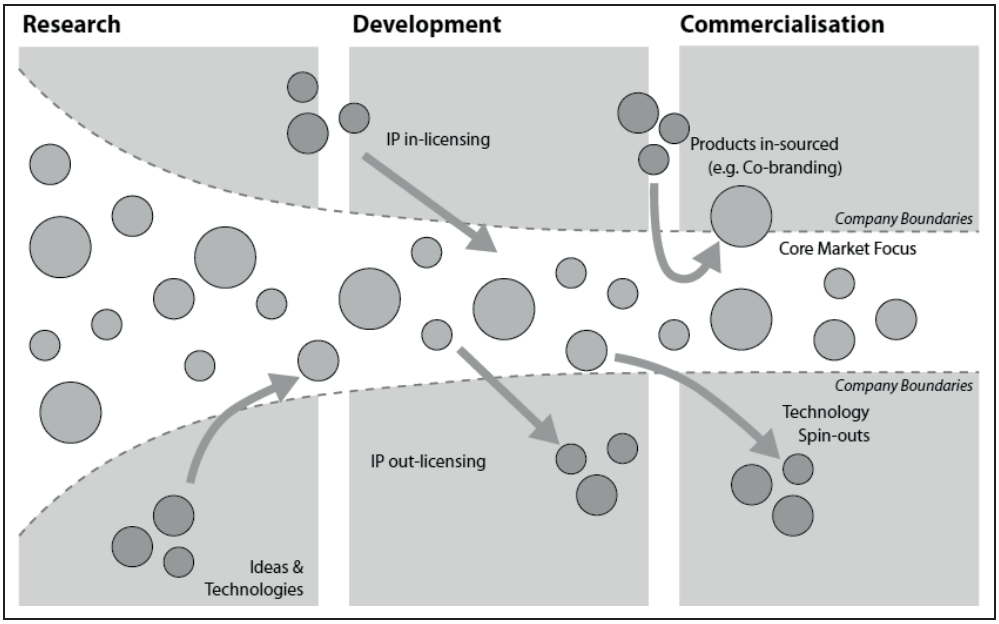
Figure 1.5: Typical scaling narrative (adapted from UNICEF, 2015)



This visualisation points to the close similarities between such a scaling approach and the innovation funnel perspective from the business sector (see Figure 1.6); this raises questions about how much the scaling innovations for development and progress approach is influenced by business model perspectives. The innovation funnel has been critiqued for becoming too much of a straightjacket and limiting perspectives of what needs to be taken into account in innovation (e.g. Vanhaverbeke, 2013). It seems only appropriate to call for a similar type of rethinking of scaling approaches along similar lines.

I tentatively conclude that the term scaling is used not just differently, but also more loosely in the context of scaling innovations for development and progress than is done in the context of science and resembles more the type of interpretation that is common in the business sector (as discussed in particular in section 1.3). It is therefore necessary to consider for each specific situation what exactly is meant when the term scaling is used. This may be part of the confusion and ambiguity that triggered my interest in studying this subject matter.

Figure 1.6: The 'open innovation funnel' (from Mortara et al. 2009:12 who based it on Chesbrough, 2003)



1.5 Rethinking the idea and practice of scaling innovations for development and progress

So, I found that the use of the concepts of scale and scaling are everything but unequivocal and clear-cut. The concepts are used in quite different ways, for quite different purposes, and refer to quite different things and processes. Still, use of the term scaling entered into the context of development and innovation initiatives, becoming a buzz word over the last decade, and it is now hard to imagine significant funding proposals that do not include a section on scaling ambitions. The key question remains as to whether the idea and practice of scaling of innovations is really sensible for achieving development and progress, and what development and progress are we then talking about?

In the following, I explain why there are good reasons for scrutinising the idea and practice of scaling innovations for development and progress and for looking for new approaches that better address (potential) implications for society at large. This is what motivated this study and defined the purpose for doing so.

1.5.1 Motivation for this study: core concerns and questions

Both theoretical and practical as well as both scientific and societal concerns and questions motivated this research. I briefly outline them in the following. This

presents the wider orientation of questions from which I later select research questions (in section 1.6).

Rethinking the concept of scaling in the context of scaling innovations

How helpful is the concept really for understanding what processes are involved in scaling innovations for development and progress? In the context of agricultural development, other terms have been used that were pretty much about the same idea, such as diffusion of innovations, transfer of technologies, dissemination of knowledge, mainstreaming of practices, and institutionalisation of change. In fact, in many instances where the term scaling is used, one may equally use a different verb. For example, we can 'scale' a particular innovation, but we can also 'make it available more widely'. Using a variety of verbs instead of just the one verb, scaling, may actually help to be more specific about what scaling in a particular situation pertains to exactly.

As briefly explored in the previous sections, the concept as used in the context of scaling innovations for development and progress may have been borrowed from rather different types of context, notably (software) engineering, production systems, marketing, and the wider business sector. If so, that would raise the question of whether it then also brought with it an interpretation that may be appropriate for e.g. the (private-goods oriented) business environment, but not for public-goods-oriented initiatives.

Finally, in the context of scaling innovations for development and progress, the term scaling is used across the range of political and ideological persuasions. I have not yet found significant studies that seriously discuss the philosophical and ideological roots of the scaling innovations approach. It is generally treated as a subject that involves asking 'how to do it' more than asking critical questions about the desirability of intrinsic processes associated with scaling. This begs the question of why this is so and what a critical assessment of its philosophical and ideological roots would mean for the scaling innovations for development and progress approach.

Rethinking the reasoning in support of scaling innovations

Is the essential idea underpinning ambitions to scale innovations for development and progress based on sound reasoning? Hardly any of the initial literature explored provided a perspective that dealt seriously with complexities involved in scaling processes. Most scaling initiatives, particularly in the context of agricultural innovation, approach scaling as a rather one-dimensional process of finding out 'what works' and doing more of 'the same'. This means that there is a risk that decision making in relation to scaling initiatives will be informed by rather simple (if not simplistic) ideas on what is involved in, and affected by, scaling processes. Could it run the risk of bringing back blueprint approaches through a common approach of

rolling out so-called solutions without appropriate anticipation of potential applications across scale levels and in different contexts?

The level of evidence needed for strong scientific evidence of causation in (e.g. agricultural) research is different from what is needed for public policy development (Grandjean, 2013). This can create a tension between what is required in research and what is needed in relation to development policy, reflecting an inherent tension within the scaling innovations approach. The strong evidence that a particular innovation works in a particular context and for a particular purpose may easily be mistaken for evidence that this would also apply for its use at scale and across other domains and contexts. It is hard to make such an extrapolation (Steel, 2008). In scientific research, only repeated correlation can provide a reasonable basis for assumed causation, but this is difficult to achieve in a context of projects and experiments that have unique features. We are left with the question of the sort of evidence that is needed to know about the effect of scaling processes and whether that knowledge will every come in time to be able to adjust incorrect hopes and expectations.

This relates closely to the question of whether what is considered good in an innovation in a particular setting, at a particular scale level, and by particular people would not be compromised in the scaling process (Menter et al. 2004, discuss related fallacies). Although most people would agree that such logic does not automatically hold true, still it appears to underpin ambitions to scale innovations. This may be similar to the transfer of technology approach, which was officially abandoned at the end of the last century but is still very much the basis of current development programmes (Gehl et al. 2012).

Rethinking the implications of focusing on scaling innovations as the key approach to development and progress

Why would scaling innovations be the approach par excellence to achieve development and progress (as many claim), and what kind of development and progress are we talking about here anyway? Is really such a splendid idea to consider scaling innovations as the key mechanism and model to achieve progress and development (see quotes in section 1.2), or could it be that it connects to particular, rather contentious, views and ideas on what makes for progress and development? In other words, why would finding models 'that work' and doing more of the same be such a good idea anyway? Could it be that there are other modes that possibly would diversify pathways and enhance societal resilience by providing more (fall-back) options for dealing with complexity (e.g. see discussions by Bannerjee & Duflo, 2012; Smart, 1999; Stirling, 2009; Norberg & Cumming, 2008)? Could it also be that the very idea of scaling (up) models, and consequently getting more of the same, holds an

inherent risk of rigidity and loss of diversity, particularity, individuality, and unique identity, with serious implications for society and the environment?

Upon closer examination of what processes of scaling intrinsically relate to, there appears to be an undercurrent of ideological thinking about how change happens and how change ought to happen. Could it be that the term 'scaling innovations' may in fact be a type of transfer of technology approach and conflict with other approaches to innovation and innovation systems that point to the need for context-specific facilitation of more emergent types of innovation processes (van der Stoep & Strijbos, 2011)?

In this context, the idea of 'McDonaldisation of society'[6] (Ritzer, 2008) is relevant, introducing questions regarding ethical, aesthetic, and other higher-concern aspects of processes of scaling innovations. It points to the fact that scaling innovations may be successful in economic terms, and yet not be desirable from e.g. a social, ethical, or aesthetic perspective. The desirability and success of scaling-up processes will tend to be assessed in relation to financial-economic benefits (for particular groups) only (Murray et al. 2010: 82). Schumacher's (1973) well-known book *Small is Beautiful* attests to the concerns people may have when thinking about taking things to scale, a concern that may have become less appreciated since this book was first published as we can often find the counter-maxim of 'small is beautiful, but big is needed'[7].

Other questions relate to power. How does the idea of finding models to scale (up) relate to issues of power, control, and freedom? Scaling of models implies a certain measure of copying, of replicating, of standards in order to ensure that more of the same is obtained. It necessitates a certain measure of compliance. It also implies that the original idea came from somewhere else. It is not a homebrew, and that affects ownership feelings of those who are meant to adopt the model. What freedom is there to change the model or even refuse the model? This is a relevant question in the context of international development where those who hold the purse-strings for development may to a large extent set the rules. Whose model is it anyway and what freedom is there to opt for alternative/adapted models or even to engage in a process of developing one's own models (see e.g. discussions by Max-Neef & Smith, 2011; Sen, 1999; Schumacher, 1973)?

Rethinking alleged benefits of scaling innovations for society

Could scaling processes be inherently prone to producing undesirable effects and implications that would call for healthy scepticism or at least serious scrutiny? There

[6] McDonaldisation is the process by which the principles of the fast-food restaurant are coming to dominate more and more sectors of American society as well as of the rest of the world.
[7] E.g. http://www.inclusivebusinesshub.org/small-is-beautiful-but-big-is-needed-why-inclusive-businesses-should-put-more-effort-in-scaling/, accessed 5 January 2018.

are a number of societal concerns directly related to the scaling of new products and practices. Climate change is the easy example, which most experts consider to be mainly caused by scaling carbon emissions. Until the link between the two processes was made, combustion engines and other contraptions producing greenhouse gases were considered to be excellent innovations. And there are many more such examples, which Gee et al. (2013) studied in their publication *Late Lessons from Early Warnings*. There may be inherent problems in the innovation (they give the example of widely used asbestos), but the problem may also arise when the use of innovations is scaled beyond a particular level (e.g. because of the effects on climate or groundwater tables, as discussed in Chapter 3). So, this is not a question of scaling bad innovations, but how 'good' innovations may have bad implications if applied at scale. Other concerns relate to land and water degradation caused by scaled-up exploitation of particular types of agricultural practice (Brown, 2005). How does this affect environmental, economic, and social sustainability and resilience (Pisano, 2012; van der Ploeg, 2008; Ungar, 2012; Walker & Salt, 2006)?

Related questions include the long-term implications of scaling innovations and related concerns for future generations. At what expense were innovations for development and progress brought to scale? Overall, there is the question of whether what we have called progress is real progress (e.g. Costanza, 2009; Gillespie, 2001; Goldsmith et al. 1995; Goudzwaard, 1997; Wessel, 2007). Can we sustain and increase achievements with the same (scaling) models with which we have built our existing affluence (for those to whom it applies)?

Picking up the theme of power once more: who has the power and influence to decide on models (innovations) to be scaled? It will not be the poor who will scale something up. In other words, it may be a certain class only that can decide to scale something up and probably along the lines of their preferences. If scaling involves a push for conformity and compliance, could it by nature run the risk of serving as an instrument for power and domination, creating dependency? This raises further questions regarding the ethical implications of dominant development models (Bailey, 2011; Gillespie, 2001). It also relates to questions of who really benefitted and who really benefits from scaling innovations? This connects to societal concerns about large-scale land acquisitions, often framed as land grabbing (Matondi et al. 2011; Cotula et al. 2009).

Finally, affluence is becoming more of a shared lifestyle around the globe, adding new and more demands on (natural) resources. It is an established fact that the earth could not sustain the level of demands on resources as are common in currently affluent countries such as in the USA and Europe if other parts of the world followed the same pattern (model) (e.g. Barnosky et al. 2012; Jackson, 2009). So where does continued scaling of innovations fit in this picture?

1.5.2 Purpose of this study: enriching perspectives and considering alternative approaches

In the previous section, I listed a variety of critical questions and concerns regarding scaling innovations for development and progress. The list confirms that there are plenty of reasons to study related issues more deeply. Yet, as discussed earlier, little attention is paid to such critical questions in the literature, but this is inappropriate given the nature and seriousness of questions raised. I argue that it is time to start thinking more critically about the scaling innovations for development and progress approach and by doing so take such processes more seriously. This involves considering the roots (reasons why it is a popular approach), practice (what it involves exactly), and fruits (short- and long-term effects) of the approach. In this thesis, I therefore set out to make three types of contribution.

First, this thesis seeks to contribute to enriching common perspectives on scaling innovations for development and progress in order to create more comprehensive and integrative perspectives that do more justice to relevant complexities and implications involved.

To enrich perspectives on scaling innovations, I explored a wide range of literature directly or indirectly related to the subject matter in order to develop an overview of what is relevant to be considered in understanding what scaling innovation is about, what motivates it, and what its (potential) effects are. To explore new analytical approaches, I connect to analytical approaches that allow for integrative analysis, thus enabling the development of more comprehensive perspectives on scaling innovations. In consulting formal and informal literature, I focused on the following seven bodies of literature (not giving equal attention to all):

- Conceptualisations of scaling innovations for development and progress (such as Barenblatt, 2005; Biggs, 2007; Holcombe, 2012; Kolijn et al. 2010; Max-Neef et al. 1991; McShea, 2010; Passioura, 2010; Ryan, 2004; Rybski, 2009).
- Scaling innovations in history (such as Arrighi, 2010; Bernstein, 2002; Escobar, 1995; Godin, 2015b; Haslam et al. 2011; Knutsson, 2009; Lin & Rosenblatt, 2012; Nederveen Pieterse, 2010; Porter & Sheppard, 2009; Ranis, 2004; Rist, 2008; Rogers, 2003; Shah, 2009; Voth, 2004).
- Wider ideas on progress and development related to scaling innovations (such as Berthelot, 2004; Bellù, 2011; Cowen, 1996; Ellul, 1990, Hopper, 1991; McCloughan, 2003; Nichols, 2011; Owen, 2002; Peet & Hartwick, 2009; Ruttan, 1997; Sen, 1999; Scott, 1999; Todd, 1926; Visser, 2010).
- Theory-oriented applications of the idea of scaling innovations (such as Anthony, 2008; Bosch & Rotmans, 2008; Chowdury & Santos, 2010; Clark, 2012; Geels,

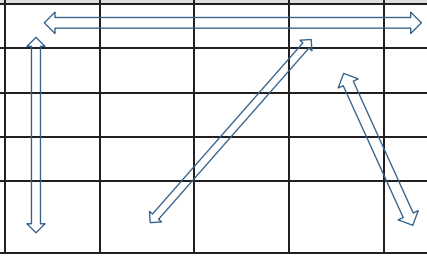
2002/2005/2010; Klerkx et al. 2010/2012; Leach et al. 2012; Levidow, 2011; Moldaschl, 2010; Oster, 2009; Schot & Geels, 2008).

- Practice-oriented applications of the idea of scaling innovations (such as Berg, 2012; Binswanger, 2003; Cash, 2011; Chambers, 1992; Chandy et al. 2012; Chandy & Linn, 2011; Cooley & Kohl, 2006; Gradl & Jenkins, 2011; Middleton et al. 2002/2003; Pachico & Fujisaka, 2004; WHO, 2009/2010/2011).
- Implications and consequences of scaling innovations (such as Baumol et al. 2007; Dale, 2012; Daly, 2008; Evans et al. 2010; Grain, 2006; Lasch, 1991; Melber, 2012; Nærstad, 2010; Niezen, 2004; Noorgaard, 1994; Smith, 2016; Steffen et al. 2015; Thurrow & Kilman, 2009).
- Alternative approaches to, and ideas on, development and progress as relevant in studying the idea of scaling innovations (such as Bannerjee & Duflo, 2012; Basu & Kanbur, 2009; Giri & van Ufford, 2004; Goudzwaard et al. 2007; Jackson, 2009; Max-Neef & Smith, 2011; Pisano, 2012; Reeves, 2005; Rockström & Klum, 2012; Röling, 2011; Schluter & Ashcroft, 2005; Schumacher, 1973; Sörenson, 2010; Stirling, 2009; Theos, 2010).

Second, this thesis seeks to contribute to the development of analytical frameworks that could help inform more inclusive sense-making in management decision making and policy development. This also involves better understanding how interactive scales and scale levels play out (illustrated in Table 1.5).

Table 1.5: Interactive scales and scale levels – a simplified illustration

Scale types relating to (e.g.):	**Scale levels related to (e.g.):**	1 *low*	2	3	4	5 *high*
Natural environment	Biodiversity					
Built environment	Road system density					
Culture	Social cohesion					
Economy	Productivity					
Ethics	Appropriate development					



Third, this thesis seeks to contribute to the development of new processes of informing decision making and policy development in relation to scaling initiatives, to help shape a practice of *responsible scaling*. This involves connecting the enriched perspectives and new analytical frameworks to management practice.

Along the lines of the need for a science of scale argued for by Wu and Li (see section 1.4.1), the three purposed contributions this thesis seeks to make can be an input into further research towards the development of not just a science of scale and scaling,

but also a philosophy of scale and scaling that would add perspectives on the roots and fruits of the idea and practice of scaling innovations in society.

Having clarified the motivation for, and purpose of, the research presented in this thesis, I now define the focus and research approach.

1.6 Research focus and methodology

There is no denying the benefits that scaling innovations (in terms of widespread application) have brought to society, such as widespread vaccination against diseases, enhanced mobility, and increased yields of agricultural crops. At the same time, the practice of scaling innovations has also led to contested and clearly negative effects. Effects will generally depend on the where (may be good in one place, but bad in another), the when (may be good in the short term, but bad in the long run), the who (may be good news for some and bad news for others), and the how much exactly (may be responsible up to some scale level, but irresponsible beyond that level).

This raises a number of questions that further unpack questions explored before: Are negative effects mere outliers, side effects that are of no great consequence? If not, and if some consequences are obviously very serious (e.g. climate change), then what causes this? Does the problem lie in the selection of improper innovations, or does it only emerge in the process of scaling? Or do we need to dig deeper and consider related ideas on progress and development that inform and drive innovation and scaling approaches and practice? And in responding to this situation, will it suffice to address issues through improved design and management practice, or does it require more fundamental reorientations of ideas on progress and development?

Somehow, the essential idea and practice of scaling innovations for development and progress appear to have largely escaped critical scrutiny, although there are many reasons for doing so and for challenging the popularity of scaling innovations for development and progress. I explored wide-ranging questions and concerns in the previous sections. This sketched the bigger picture within which I focus on particular dimensions and dynamics. However, this pertains to more than this study can address. In the following, I therefore describe the questions on which this thesis focuses.

1.6.1 Research focus

This research focuses on the use of the concept of scaling in the context of scaling innovations for development and progress. Therefore, I do not delve into all the details of wider applications of the concept in the natural and social sciences. I have sketched different types of usage in that context in section 1.3 and make brief reference to it in the following chapters, but this is generally meant for the purpose of distinguishing different types of usage – many of those who are involved in initiatives for scaling

innovations bring their scientific background with them – and I do not try to conclude anything along those lines, as related discussions and debates are far too complex and diverse to be treated as a side-topic.

The thesis focuses on the context of agriculture. Scaling innovations features prominently in that context, such as in relation to the green revolution (e.g Pingali, 2012)), the agricultural research for development approach (e.g. Maru et al. 2016), and ideas on sustainable intensification (e.g. Gunton et al. 2016). I do not, however, just restrict the research to the context of agriculture, but also explore experiences in, and ideas from, other sectors. The final chapter therefore also considers implications of findings beyond agriculture, particularly for international development in general. Interestingly, agriculture provides some good metaphors for scaling processes, such as self-seeding (involving genetic variations, with wind, water, animals, birds, and insects being common agents), suckering (self-replication), cuttings (replication), broadcasting seeds (people as agents), grafting (connecting replication to favourable conditions as package), and tissue culture (sophisticated replication).

As mentioned earlier, I acknowledge the many positive effects that the scaling of innovations has had and can have for society. However, I consider others to have made that positive case already, and I therefore pay more attention to potential complications and negative effects in this thesis and to the associated need for careful consideration of appropriate (management and policy development) practice.

Section 1.5.2 defined three purposed contributions that this thesis seeks to make: 1) enrich perspectives on scaling innovations for development and progress, 2) develop related new analytical approaches, and 3) translate this into suggested processes for informing decision making relating to scaling initiatives. There is some tension between these orientations in the sense that it is presupposed that it is useful to explore new analytical approaches even though critical perspectives may seriously challenge essential ideas of scaling innovations. Rather than trying to resolve this tension, I decided to approach both orientations with an open mind and revisit this tension in the last chapter.

Given the questions and topics raised earlier in this chapter, I selected research questions in this thesis along the lines of the above three categories:

Rethinking perspectives on scaling innovations for development and progress. I focus on philosophical-type questions:

1. What type of thinking, ambitions, and orientations commonly underpin and motivate the *essential idea behind* scaling innovations, and what are the related biases, complications, and societal concerns?

2. What types of negative effects can scaling innovations have on nature and society and what helps to better anticipate and reduce such effects?

Rethinking analytical approaches for considering scaling innovations for development and progress. Here, I focus on analytical-type questions:

3. What commonly informs *management processes* (including design and strategy) relating to the scaling of innovations, and what are the related limitations and vulnerabilities?
4. What analytical approaches, methodologies, and frameworks can help enrich perspectives on the implications of scaling innovations, and what dimensions and dynamics do these need to take into account from design to evaluation of scaling initiatives?

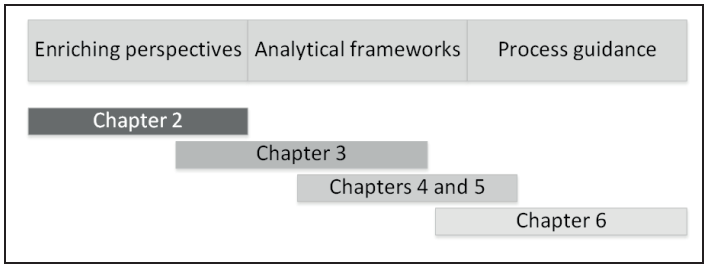
Rethinking processes for informing scaling initiatives towards a practice of responsible scaling:

5. What can we learn from the empirical application of alternative analytical approaches in assessing a scaling initiative retrospectively (ex post) and prospectively (ex ante)?
6. How can decision-making processes (including policymaking) benefit from the suggested methods and approaches as discussed in relation to the above five questions towards advancing what may be framed as responsible scaling practice?

Chapter 2 addresses questions 1 and 2 specifically. Chapter 3 bridges questions related to the two main categories of research questions, addressing questions 2 in a limited way, and focusing on questions 3 and 4. Chapter 4 addresses question 5. It concerns an ex ante case study of what to take into account in scaling 'green rubber' practice. Chapter 5 also addresses question 5. It concerns an ex post study of reasons for disappointing scaling and institutionalisation of cocoa farmer field schools in Cameroon. Chapter 6 addresses question 6 in light of questions 4 and 5. It explores the utility of developing *theories of scaling* in the context of contributions to sustainable development. Figure 1.7 schematically shows the orientation of the chapters in relation to the three focus areas of research.

As the focus of this thesis is on scaling innovations, I particularly seek to connect to critical thinking in relation to the concept and practice of innovation, and more specifically

Figure 1.7: The orientation of the chapters in relation to the three focus areas of research on scaling innovations



the idea of responsible innovation, to consider how the development of critical thinking on scaling could link to, and/or benefit from, insights in that field.

1.6.2 Research methodology

The research methodology is based on a two-pronged approach in line with what this thesis intends to contribute: enriching perspectives and developing appropriate analytical approaches. As regards taking stock of documented ideas on, and the practice of, scaling innovations for development and progress, much groundwork had already been done (Anderson, 2012; Clark, 2012; ExpandNet, 2011; Fixsen, 2009; Ryan, 2004). This provided a good starting point for creating an overview, after which I further expanded upon this work to get beyond the instrumentalist focus of most of the documented literature. The thesis research was developed along the following lines, not always in the exact chronological order in which related work was done:

1. Comprehensive review of formal and grey literature as well as direct engagement with research practitioners interested in, and/or engaged with, scaling initiatives;
2. Performing a critical assessment of essential ideas underpinning the scaling of innovations for development and progress, exploring the types of literature as outlined in the above (Chapter 2);
3. Considering the relevance and utility of existing methods and frameworks, development of alternative and/or complementary methods and frameworks to help enrich perspectives on what affects and is affected by processes of scaling innovations (Chapter 3). The development of related methods and frameworks involved feedback from co-authors, and from peers during a conference on systems research at the International Institute of Tropical Agriculture (IITA) (2015), based on initial designs. This informed a refining of frameworks and of the articulation of the line of argument.
4. Testing the developed methods and frameworks in two case studies: scaling green rubber in Southwest China (Chapter 4) and scaling and institutionalising cocoa farmer field schools in Cameroon (Chapter 5). For the green rubber case, the application involved four main steps: 1) selecting and adapting methods and frameworks as described in Chapter 3 to fit the specific context of the case study; 2) interviews with key informants in Southwest China along these lines; 3) complementary literature research on rubber cultivation; and 4) discussion and presentation of implications for possibilities to see green rubber practice go to scale based on the findings. For the cocoa farmer field school case, the application involved five main steps: 1) selecting and adapting methods and frameworks as described in Chapter 3 to fit the specific context of the case study; 2) interactive (with first co-author) identification and further development of key sources of information based on data already available from field research performed by the

first co-author; 3) complementary literature research on farmer field schools; 4) analysis of the data by applying selected analytical frameworks; and 5) presentation of discussion and conclusions on main reasons for disappointing scaling and institutionalisation of cocoa farmer field schools in Cameroon. Further details on the specific case research methodologies can be found in Chapters 4 and 5.

5. Based on learning from initial application of methods and frameworks, further refining and complementing of such methods and frameworks (Chapter 6). This revolves in particular around the idea and application of *theories of scaling*, which relates closely to the common use of theories of change and therefore enhances the communication of ideas and frameworks such as presented in Chapter 3. Development of this perspective was informed by a booklet that I wrote in late 2016 on theories of scaling, benefitting from comments on it from peers.
6. Revisiting research questions, considering what has and has not been addressed and what further steps could be taken to develop rich perspectives on scaling innovations and to develop practical guidance for decision making and policy development in support of responsible scaling (Chapter 7).

The combination of a philosophical angle on the topic with a practice-oriented angle has helped to create new perspectives, but also meant that a trade-off had to be made between in-depth empirical research and wide-ranging literature review and development of such new perspectives. Although I was clearly in the driving seat when writing the chapters and developing frameworks and lines of argument (except for Chapter 4 in which the driving seat was shared with the first author), I purposefully involved co-authors to fine-tune my ideas and thinking on an ongoing basis. The main reason for doing so is that I am taking a rather different route than is common in terms of engaging with the topic of scaling innovations and I wanted to prevent myself from straying too far from that with which purposed readers of this thesis would be able to associate. This thesis may inform management and policy development (relating to scaling initiatives) as well as wider research on implications and complications of, and alternatives for, scaling innovations for development and progress.

1.6.3 Outline of thesis

The following provides a brief impression of the focus and purpose of the chapters of this thesis:

Chapter 2 focuses on questions related to the ideological roots of the idea and practice of scaling, considering implications and ways in which to move towards an ethics of scaling innovations along similar lines as the already more developed ethics of technology and ethics of innovation.

Chapter 3 explores possibilities for developing methods and frameworks to guide the development of more comprehensive and systemic perspectives on scaling agricultural innovations to remedy the narrow scope of common perspectives on the same.

Chapter 4 applies methods and frameworks as presented in Chapter 3 in the context of a study on scaling green rubber in Southwest China, pertaining to an ex ante analysis of what to consider in developing appropriate scaling strategies to help green rubber practice go to scale.

Chapter 5 applies methods and frameworks as presented in Chapter 3 in the context of an ex post analysis of a programme that aimed to bring to scale the practice of cocoa farmer field schools in Cameroon. One of the main purposes of this analysis was to find out how useful the development of broader perspectives on scaling innovations is for understanding relevant factors that play a role in the success or failure of scaling initiatives.

Chapter 6 further explores opportunities for developing frameworks to guide scaling initiatives towards responsible scaling practice. The focus is on applying the concept of theories of change towards a perspective of *theories of scaling* with the purpose of using it to better inform scaling initiatives to make scale work for sustainable development.

Chapter 7 revisits the research questions and the defined purpose of this study, considering what the various chapters have addressed in that regard and touching on relevant other topic areas that could not be addressed (fully) in this thesis. This leads to a number of suggestions for further research and development along similar lines as explored in this thesis.

CHAPTER 2

Scaling under scrutiny. A critical assessment of the idea of scaling innovations for development and progress

2

To be submitted in abbreviated form as Wigboldus, S., Jochemsen, H., Scaling under scrutiny. A critical assessment of the idea of scaling innovations for development and progress.

2.1 Introduction

In recent years, the use of, and reference to, the term 'scaling', and particularly 'scaling up', have increased significantly in the context of (agricultural) development and innovation planning (Anderson, 2012; Fixsen, 2009; Ryan, 2004; Wigboldus & Leeuwis, 2013). The term is used widely across sectors from energy, information technology, and business, to health, social innovation, and agriculture. The concepts of scale and scaling are also widely used in science, from Mathematics and Physics to Geography and Ecology, but mostly in rather different and more specific ways than how they are used in common language.

In this chapter, we focus on questions relating to the idea of scaling innovations as a key mechanism towards achieving development and progress. Related ambitions may range from more specific objectives such as increased productivity, to broader societal agendas such as associated with the Sustainable Development Goals (SDGs). Innovations are the centrepiece in such efforts. These refer to innovative products, practices, and projects in which technologies often feature prominently. New crop varieties, new business models, and new multi-stakeholder partnerships are examples, but also included are innovations in food habits (e.g. increased production and consumption of processed food and animal protein). The wider use and application of such innovations is largely propagated through marketing methods and subsidising, where the focus is primarily on 'scalability' (the possibility of innovations 'going to scale'), described along the lines of supply–demand mechanisms (Cooley & Kohl, 2006; Middleton et al. 2005; Gillespie, 2004), where desirability is generally assumed. In this context, the term scaling is about more than a methodological concept and is more loosely defined than in scientific research. It revolves around identifying particular techniques, practices, and projects to be scaled in terms of wider or more encompassing application. A popular adage in this is to 'find out what works and do more of the same' (Wigboldus et al. 2016). The question of what works will be answered differently by different people, but the essential idea of scaling that which is considered 'to work' as a pathway to development and progress is rarely challenged. Several authors have articulated the generally highly held expectation of scaling innovations as a key mechanism and model for achieving development and progress (e.g. see Olson, 1994; Ezilov, 2011). It is essentially based on the reasoning that, by scaling innovations, the gap between the scale of problems (or societal ambitions) and the extent to which these are addressed is bridged (Ryan, 2004). *Such reasoning is apparently so compelling that hardly any literature can be found that explores, let alone challenges or criticises, the assumptions and ideological orientations underpinning this reasoning.* This chapter addresses this apparent lack of critical assessment, making a case for the need to approach the scaling of innovations for development and progress more critically than is commonly done. In this, we focus not so much on the way in

which scaling initiatives are designed and managed (we explore this in later chapters), but on essential ideas on, and approaches to, achieving progress and development that underpin the ambition of scaling innovations, on societal processes into which such scaling feeds, and on associated areas of societal concern, contention, and debate. Making this point involves treating scaling processes in their own right, as distinct from (but connected to) questions relating to technology and innovation.

The key questions addressed are: What are the origins and history of the popular usage of the idea of scaling innovations for development and progress? How prominent are scaling processes (in terms of scaling innovations) in society? What are the core implications of the scaling innovations approach? Why is the term scaling used in so many instances when other words would be perfectly suitable or even more suitable? What key narratives motivate the scaling of innovations? What are the areas of contention in scaling innovations for development and progress? Our assessment was guided by, and at the same time tested, the hypothesis that the idea of scaling innovations for development and progress connects to societal and scientific debates on issues related to development planning, ideas on progress and economic growth, as well as on issues regarding the role of innovation and technology in society. Even though the scaling processes relating to innovations are rarely specifically addressed in those debates, we argue in our later discussion that they should be.

Although we approach the idea of scaling innovations for development and progress in a critical fashion, we do acknowledge significant societal benefits resulting from such processes. Indeed, some innovations would not have worked or been affordable unless produced and used at scale (e.g. mobile phone technology). However, we consider that the positive case has already been made sufficiently and therefore we limit ourselves here to a critical assessment of scaling innovations. This assessment may be useful for those who play a role in research, decision making, and policy development related to scaling innovations, as it provides them with a background on what it may involve and what needs to be taken into account, in ways that are not commonly explored.

Methodological remarks

This assessment is based on wide-ranging literature research that included scientific articles, books, and grey literature. The last category proved to be a key source for more critical considerations about processes of scaling that were more difficult to find in scientific articles; these generally take the term scaling as a rather neutral term (politically speaking). As we discuss in section 2.2.2, the concept of scaling may be 'lost in translation' when other words are used to describe processes that are in fact all about scaling but are not framed that way. Finding this out at some point in our

research, we decided to cast our nets wide in terms of literature research to capture not just use of the term scaling and related discussions, but also that which scaling is essentially about even if framed differently.

We therefore specifically consulted literature that critically discusses concepts and practice related to the ideas of 'development', 'progress', and 'growth', including reflections on their history. We furthermore focused on more recent societal debates and related literature as regards moving towards sustainability (in the wider sense of the word), including topics such as climate change, environmental degradation, and social conflict, paying particular attention to agriculture.

Section 2.2 briefly traces the use of the concept of scaling in history and identifies scaling processes as being at the heart of common societal trends including industrialisation and globalisation. Section 2.3 considers three inherent implications of processes of scaling innovations that characterise the nature of such processes. Section 2.4 characterises core narratives that motivate the idea of scaling of innovations for development and progress in terms of rhetoric, paradigm, and ideology. Section 2.5 debates the areas in which the practice of scaling innovations for development and progress should be approached more critically and how this could be done. Section 2.6 provides three fields in which the critique on the scaling innovations for development and progress approach may be translated into guidance for management and policy development. Section 2.7 draws conclusions from the preceding sections along the lines of the research questions, while suggesting research ground that still needs to be covered. This chapter does not aim to provide a full story of the implications and complications of scaling innovations for development and progress, but rather identifies a much-needed direction in which related thinking and practice should be the object of critical discussion and debate along similar lines as debates on technology and innovation.

2.2 Tracing the origins of scaling as concept and process

There is no way to do justice to a topic as big as tracing the origins of the concept of scaling and its related processes in society in the space we have here. In Chapter 1, we explored the more recent history of the use of the term scaling in the development context. This section provides an overview of processes associated with scaling innovations in society and a brief exploration of the origins of the current popularity of scaling innovations for progress and development.

2.2.1 Scaling in history

Godin (2015b) explained how innovation (particularly in terms of innovative ideas) used to be frowned upon in history and only in the last century became something to

be pursued actively. In the following, we are not referring to that which would be phrased as innovation in the past, but rather more broadly to inventions such as new practices, new tools, and the use of new materials, how these went to scale and the associated effects.

Scaling as a natural phenomenon is as old as the world and a core process in the universe with its expanding galaxies, and on the earth with rising and falling sea levels, growing populations, and more. Scaling as a social enterprise is as old as humanity. One of the best-known stories from early history is that of the tower of Babel. Literally and figuratively, people tried to scale the heavens. The story did not end well. It is a theme picked up by Leopold Kohr (1957) in his book *The Breakdown of Nations* in the middle of the last century when achieving scale was becoming a more prominent focus in society. According to Kohr, striving for bigness (eventually) cripples the beauty in society and leads to its breakdown. Schumacher (1973) picked up this argument in his well-known book *Small is Beautiful*. Others have since followed up on this theme, such as The Club of Rome's *Limits to Growth* (Meadows et al. 1972), the IAASTD publication *Agriculture at a Crossroad* (McIntyre et al. 2009), and the European Environmental Agency's publication *Late Lessons from Early Warnings* (Gee et al. 2013), exploring related concerns.

The scaling of innovations, throughout history, has been one of the key drivers of change in societies, such as the use of wheels, bronze, iron, ships, gunpowder, military technology, medicines, fertiliser, or more recently the combustion engine and information technology. Scaling innovations generally combines quality (innovation) with quantity and scope (scale). When a new invention produced an innovation, the historical tendency was to focus on this as a 'silver bullet', focusing on quantity (e.g. size of army or amount of gold). A wise chancellor of one of the Mongol emperors in the 13th century is said to have advised that a country conquered on horseback cannot be ruled on horseback. Mongol armies were feared widely, but they could not sustain their empire for long. Roman armies were not necessarily the biggest, but they were the best organised. Leonardo da Vinci's inventions (or at least designs of these) were and are coveted by many, as they were considered to hold a potential for breakthroughs and a shifting of power balances. Printing (process), the steam engine (product), the scientific method (approach), application of international law, and sanitation (behaviour) are indeed among innovations that have changed the world because they were embraced widely (scaling), clearly also in positive terms. Such innovations have been a stimulus for ideas on aspired progress and development.

Definitions of development and progress are often based upon the way in which a person (or a group of people) pictures the ideal conditions for social existence. This, however, reduces it to no more than the sum of virtuous human aspirations (Rist,

2010:10). And that means that "every human activity can be undertaken in the name of 'development'" (:11). Rist goes on to describe development as an element of modern religion, in the sense that many believe in it although many indicators of the effect of pursuing it are sending warning signals. The Enlightenment presented the idea of progress as moving from ignorance and superstition to science and rationality, from spirituality to materiality, and from stewardship over what is considered as being entrusted to humanity to master-ship over what humanity manipulates towards its own purposes (Ellul, 1964; Goudzwaard et al. 2007; Smith, 2016). This is the interpretation of the idea of progress that we take as reference. Sustainability may be considered a continuation of the Enlightenment doctrine of progress that includes small but significant changes regarding Western culture's imagined relationship with its future (Vollrath, 2012).

Rist (2010), although not elaborating on alternatives quite as much, concludes at the end of his *History of Development* that the concept of development has become entangled with the obsession about unlimited economic growth (:261). He blames much of this on the fact that economic science, which he considers to be no more than a battle of opinions, "fluctuates according to the conjuncture in ways that enable the strongest to impose their will" (:261).

Ideas on progress and development have been much discussed and debated (Peet & Hartwick, 2009). We focus here on processes relating to development and progress at scales (from less developed to more developed) and how innovations feature in moving up such scales. After WWII, with the Marshall Plan, the concept of development got into full swing, particularly in terms of using the scale of underdeveloped to developed (see also Box 2.1). GDP became the main yardstick of 'development', i.e. production (Rist, 2010). Gradually, 'development' became a necessary prerequisite for becoming part of the world economy (Final Communiqué of the Asian-African Conference, Bandung, Indonesia, April 1955, quoted in Rist, 2010:83–85), where 'development' models of industrialised countries (notably the USA) were promoted (:88). From there, institutions were installed to promote 'development'. Rostow (1960) developed a scale for development that for many, consciously or unconsciously, became a reference point. It is based on an evolutionary idea of development as moving through stages linked to production and consumption. The scale involves the move of societies into 'better' conditions, ranging from traditional society, to preconditions for take-off, to take-off, to a drive to maturity, to the ultimate age of high mass consumption. Ever since, the economies of growth and economies of scale (efficiency) have deeply shaped political thinking, also evident in the fact that such conceptualisation is not unlike current ways of guiding scaling initiatives from conditions for scale-up, to scale-up, to sustained growth, culminating in impact at scale (e.g. Little, 2012).

Box 2.1: Scaling innovations as part of a political process of industrialisation

Visser (2010, 2013) describes how industrialised agriculture in Europe, and in the Netherlands in particular, became rooted in chemical inputs based on an ideology, and not on sound research and practice. He explores the role of WWII in distorting scales as production became totally geared towards a war economy. In this process, he writes, large industries were able to establish a position of power by leaning close to the government, securing their financing and conducive regulations. Industries thus scaled up and were launched into positions that affect agriculture to this day. According to him, it is no coincidence that the production of explosives (needed during the wars) relates closely to the production of chemical fertilisers. After the two world wars, a new reality emerged regarding who financed and directed choices regarding (agricultural) research, and the industrialisation of agriculture got into full swing. Agriculture was regarded as backward compared to industrial production methods. As industrialists became influential in designing a new (agricultural) economy, they started to press their factory-type designs as a mould on agriculture, treating plants and soils as mere means of production. Visser (2013:41–42, emphasis added) refers to this as "full-blooded faith in 'factory methods' where research and design would lead to *'products' that would be applicable everywhere*. Before long the evident need of the times to *accelerate production* so that life would become at least materially tolerable issued in projects of ongoing 'wealth production'". Voices of dissent were neglected, in particularly the Finnish biochemist Artturi Virtanen who won the Nobel prize for chemistry in 1945, and who had demonstrated how intensification of food production was possible by intensification of biological nitrogen fixation and that chemical fertiliser was not needed for that (Visser, 2010, 2013). The factory-based design of agriculture introduced the concept of agricultural production as creating crops in a factory, thus neglecting intricate biological and social processes involved (Schipper, 2016).

2.2.2 Societal trends as scaling processes

In this section, we further explore societal processes in relation to the scaling of innovations with which we started in the previous section, for a moment forgetting about the specific use of the term scaling and focusing on what it is about. What it is about may be conveyed through many other words as well (or even better), depending on how exactly they are used and in what context. These include terms such as dissemination, diffusion, expansion, and increase. We discuss this in more detail in other chapters. There is, however, a whole other class of terms that are all about scaling, but rarely framed as such. These terms describe processes (in particular trends) that have happened throughout history and are still happening today. Many of these terms end on 'isation' (it does not apply to all words that end this way!), where the 'isation' actually is all about the process of scaling, and the preceding part of the word identifies the relevant scale. Once alerted to this pattern, it was not difficult to identify many examples: Hellenisation (the increasing impact of Greek culture resulting in more and more cultures becoming similar to Greek culture), Romanisation, Westernisation, bureaucratisation (the increasing impact of regulatory offices, as well as rules and regulation, on society), colonisation, standardisation (application of a particular standard becoming widespread practice),

McDonaldisation (principles of fast-food restaurants become dominant in more and more sectors in the USA and worldwide (e.g. Ritzer, 1998, 2012; Drane, 2012). Such terms are also applied in a cultural version as the homogenisation of cultures (e.g. Nederveen Pieterse, 2009), civilisation, indigenisation, and technocratisation (increasingly leaving decision making to 'experts'). Often such terms are used to frame particular processes that involve debate in which the very framing is part of communication strategy (Fiss & Hirsch, 2005; Lieshout et al. 2014). Table 2.1 further explores a selection of such processes. They involve a particular practice or process (e.g. industry-style production) *going to scale*, thereby becoming a cultural change process affecting society *at scale* (put in a formula: industry-style production x scale = industrialisation).

Table 2.1: Scaling as core process in societal trends and movements

Concept	Description and related scales	Related type of societal concerns
Modernisation	Modernity involves extremely rapid change (dynamism), unprecedented scope of change (globalisation) (Giddens, 1990), and a logic of control and domination of nature (Vollrath, 2012).	Manufactured risks are risks produced by the modernisation process, particularly by innovative developments in science and technology (Beck, 1992). We start to worry less about what nature can do to us, and more about what we have done to nature (Giddens, 1999).
Industrialisation, mechanisation	Associated with a move from agricultural production to manufacturing, as well as the prevailing of economies of scale, mass and large-scale production, and the centralisation of labour in a built environment.	Industrialisation of agriculture forces farmers in directions in which they actually do not want to go, constraining their options (Hendrickson & James, 2005); industrialised agriculture built solidly on chemical inputs as a political construct based on an ideology, and not on sound research and practice (Visser, 2010, 2013).
Technologisation	To make technological; to modernise or modify with technology[a]; a rationalised process of (methodological) standardisation through (use of) technology (Stone, 2006); transcending limitations of humanity through technology (Tirosh-Samuelson, 2017).	Religious values transferred to technique/technology that makes people ready to sacrifice persons to it (e.g. through effects of environmental degradation to next generations) (Ellul, 1997; Toly, 2005). Technologisation of life and the psyche (technology as Trojan horse being given a basis of power and influence to those producing and controlling technologies) (Marcuse, 1964; Ruivenkamp, 2008). Some see biofortification of staple crops as a Trojan horse for the acceptance of genetically engineered food and further consolidation of corporate control on food and agriculture (Daño, 2014).

Secularisation	The declining scope of religious authority in public and private life (Chaves, 1994).	Technology, the ideology of progress and development becoming the new religion that legitimises choices and actions (e.g. Byrne et al. 2002; Rist, 2010).
Scientisation (or scientification)	The impact of science on both the structures and the self-descriptions of modern societies, or, more specifically, the transformation of political conflict into a debate among scientific experts separate from the social context in which it unfolds (Kinchy, 2012:25; Latour, 2017).	Science requires logical explanation that can be reduced to mechanistic explanation (machines), leading to life going out of biology, whereas a more dynamic logic keeps logical understanding and mechanistic realisations apart (Henning & Scarfe, 2013). Reducing reality to what we can study through the scientific method (Stein & Harper, 2013).
Commercialisation	Moving towards widespread production of agricultural crops for sale in the market, rather than for family consumption, and/or a shift from traditional crops to cash crops; accelerated process since the 1980s (e.g. Nadkarni & Vedini, 1996). The increasing drawing of more domains of life, such as recreation, leisure, health, and cultural activities, into the sphere of commerce and subjected to the calculations of money (which is the associated process of monetisation) (Goudzwaard et al. 2007: 89)	Replacement of integrated farming systems by specialised enterprises for crop, livestock, poultry, and aquaculture products (Nadkarni & Vedeni, 1996). Critics of agriculture commercialisation contend that, if the resources used to produce agricultural export crops were used instead to produce food for the local economy, the problem of malnutrition in many countries could be reduced (Babu & Sanyal, 2009).
Commodification	Goods or services losing intrinsic significance and becoming interchangeable, especially through monetisation reducing them to financial-economic value (related debate discussed by Long et al. 1986)	The ethical debate on the dichotomy between the commodification and intrinsic value of farm animals (Harfeld, 2010)
Globalisation	Globalisation is not the same as internationalisation; it refers to global economic integration into one global economy, mainly by free trade and free capital flows, and easy or uncontrolled migration (Daly, 1997)	Loss of cultural identity (Niezen, 2004). Challenges in agriculture are no longer about regional discrepancies and scale mismatches, but represent a global crisis (van der Ploeg, 2008). See also monoculturalisation and McDonaldisation.
Mono-culturalisation	Two possible interpretations: Expanding practice of monoculture in agriculture (e.g. Grain, 2006; Michaels, 2011) or reconstructing societies towards one (social) culture (e.g. Conversi, 2007).	Exhausts soils, breeds plant diseases, produces huge weed and pest problems, leads to serious livelihood risks (Uekoetter, 2011); loss of food varieties and of cultural diversity (Jacques & Jacques, 2012).

Financialisation	The increasingly important role played by financial markets within a sector (notably the agrifood sector) (Clapp, 2014; Isakson, 2013; Lawrence, 2015).	From small-scale, autonomous, and ecologically sustainable craft to a corporate assembly process that relies on patented technologies and equipment financed through increased indebtedness (Russi, 2013); connected to the problematic of the general process of globalisation (Peralta, 2017); exacerbates land (green) grabbing (Dell'Angelo et al. 2017; Fairhead et al. 2014). Those who take risks are no longer the same people as those who bear them (Luyendijk, 2015).
Goalification	Translating global challenges into global goals (adapted interpretation from Dubord, 2010) and streamlining efforts in relation to these goals. Doing so creates a shared perspective on development.	Reduction of actually needed goals undermines the whole endeavour, root causes of challenges are insufficiently catered for, and monitoring of achievement is prone to political interest and associated bias (Winkler & Williams, 2017).
Agricultural intensification	Essentially referring to the aim to produce more outputs with more efficient use of all inputs, while reducing environmental damage, which means a focus on productivity (FAO, 2011; Pretty et al. 2011).	It may justify intensification per se and accelerated adoption of particular forms of agriculture (Godfray, 2015); lack of specificity and explanation about the rationale, scale, and farm type for which it is proposed (Niamh et al. 2017); given the unsustainable impacts of intensified agriculture to date, the terms 'sustainable' and 'intensification' do not sit well together (Lewis-Brown & Lymbery, 2012).

[a] http://www.dictionary.com/browse/technologised

This further demonstrates how scaling processes have been part and parcel of human history. They have been more or less consciously promoted or caused, and they often involve intense debate. Current ambitions in relation to scaling innovations for development and progress are often part of such history and therefore deserve specific attention in such debates, as scaling has become considered a (politically speaking) rather neutral term in business and development circles – as long as it concerns something 'good', scaling will only extend benefits.

2.2.3 Sweet and sour fruits of impact at scale

The common denominator for the processes discussed in the previous section is that they are all about working things in one particular direction, making things, people, and culture increasingly have the same or at least similar characteristics (uniformity). In scaling terms, it means moving particular characteristics up or down on a particular scale, such as less or more diverse, less or more standard, or less or more commercial.

Possible implications can be traced in similar words ending on '(is)ation'. Industrialisation, in many cases, has led to environmental (soil) degradation (Montgomery, 2012; Visser, 2010), to carbonisation of the atmosphere, and to acidification of oceans. Financialisation in the agricultural sector has in some cases led to expropriation of community lands (Clapp, 2014; Fairbairn, 2015). And so on. But this is nothing new. In relation to soil degradation, Montgomery (2012) demonstrates that this is not just something of the last decades or even centuries, but that soil abuse (at scale) is as old as the history of Mesopotamia, Ancient Greece, the Roman Empire, China, European Colonialism, Central America, and the American push westward. Inappropriate irrigation (innovation) played a major role in this. In other words, impact at scale has been happening for millennia, so much so that we now talk about the Anthropocene (Galaz, 2014), which essentially comprises the scaled-up technosphere (Haff, 2013) and human ability to have impact at planetary scale. In this light, the popular reference to an ambition to achieve impact at scale should perhaps be met with reservations rather than with enthusiasm. We have already had, and are having, impact at scale. For one thing, such generalised ambition to achieve impact at scale may be considered inappropriate, and secondly, even when specified further as something like 'scaling up food security' (e.g. Power et al. 2012), this can be misleading, because food security as such cannot be scaled up and will in most cases be about scaling up more concrete things such as technologies. The argument will be that this time technologies are better (e.g. Lehmann-Waffenschmidt, 2007). So, if such things as food security, nutrition, or productivity as such cannot be scaled up, this raises the question of whether framing ambitions in terms of e.g. scaling food security, is, consciously or unconsciously, concealing the fact that this is actually all about scaling innovations (especially technologies). Few would be against scaling food security or climate-smart agriculture. Quite a few more would be against scaling biofortified crops or GMOs as a pathway to food security though (e.g. Daõ, 2014; McNaghten & Carro-Ripalda, 2016). So, it may be very strategic to frame ambitions in terms of scaling commonly agreed goals (generalised as impact at scale) and divert attention from what really gets scaled up, as it may be much contested. Few would support ambitions framed as commoditisation, financialisation, globalisation, industrialisation, or modernisation, but that may in effect be the implication of scaling innovations that are part and parcel of ambitions to achieve impact at scale.

We then find that scaling innovations is a highly sensitive process with the potential to cause long-term changes that may seriously upset conditions for society and life in general. This would be one reason to approach the scaling of innovations for development and progress with healthy scepticism. In the following sections, we further explore implications of scaling innovations.

2.3 Inherent implications of scaling innovations

In this section, we discuss three core implications of scaling innovations for development and progress to characterise what shapes the nature of what such scaling is about.

2.3.1 The technology orientation

In this section, we discuss the implications of the high expectations of technology as the centrepiece in scaling innovations, as well as related debates (see also Blok & Lemmens, 2015). This includes processes associated with the introduction of technology (van der Stoep & Strijbos, 2011).

Scaling ambitions in relation to development and progress more often than not revolve around particular innovations that often (but certainly not always) involve technologies. Boss and Tichenor (2016) speak of agriculture as a temple to technology. These innovations are frequently framed as 'solutions' that support the achievement of set objectives (in relation to experienced challenges) where wider use/application depends on institutional conditions (related to e.g. governance, regulations, or persuasions) – hence the increased (since the 2000s) attention on the role of institutional innovation (framed by some as vertical scaling) (e.g. Menter et al. 2003) for development and progress (e.g. Röling, 2009). This can also be translated into a focus on institutional innovation for the purpose of making technical/technological innovation possible (Schut et al. 2016). Such approach, although correct in its asserted importance of institutional conditions, may in fact involve social engineering if the purpose is to get people to adopt certain technical/technological innovations, requiring behaviour change among actors. A compound assertion is involved here, one element being the assertion that certain technical innovations should be used/applied widely, and the other element that people need to change their behaviour and related practices and policies to make this possible. This raises ethical concerns about related agendas for social change. Institutional innovation is often needed to improve living conditions, but, in (agricultural) development initiatives, institutional innovation is often also approached as a way of paving the way for the adoption of new technologies.

At societal level, innovation is perceived as one of the key drivers of economic growth and the ultimate solution to present welfare-related problems in the West (Gripenberg et al. 2012) (see Box 2.2). With (grand) challenges further going to scale, it seems reasonable to aim to take innovations to scale (as 'solutions' emerging from the process of innovation) to try to bridge the gap between the scale of challenges and the scale of effectively addressing those (Ryan, 2004). However, thirty-five years ago, Rogers (1983) noted that only 0.2 percent of innovation research articles addressed

consequences of innovation, and this situation does not appear to have improved much (quoted in Gripenberg et al. 2012). From our literature research, we would assert that it is no different for the scaling of innovations, or rather even worse. A dominant assumption is that 'innovation is good', even without considering the consequences. This is also framed as the 'pro-innovation bias' (Blok & Lemmens, 2015; Karch et al. 2016), which limits the ability of decision makers and change agents to anticipate unintended and undesirable consequences. The bias has been recognised and discussed for 50 years or more (Gripenberg et al. 2012), but it is still alive and well, demonstrating that it is rooted in something deeper, which Miles et al. (2007) call the ideology of innovation. Others have discussed technology as ideology (e.g. Ellul, 1964; Habermas, 1992; Schuurman, 2005). In this, ideology refers to that which legitimises something without requiring evidence or confirmation of its quality and appropriateness, rendering it unquestionable.

Box 2.2: Innovation for development and progress

It was only after WWII that innovation became understood as technological innovation and generally at the service of economic growth and progress. Optimism about technological possibilities spilled over into optimism about technological innovation and innovation in general. It became something of uncontested value (Godin & Vinck, 2017:5). Technological innovation has become understood as the whole package of the commercialisation of goods and services from invention to diffusion and has become an instrument for achieving political and social goals (Godin, 2015b). Blok & Lemmens (2015) argue for the importance of understanding innovation as a process that is not just about technical and technological innovation, especially in the context of the concept of responsible innovation.

Scaling innovations for development and progress therefore links directly to debates on technology, even if (as we found in our literature research) it is not a distinct topic as such in those debates. All critical thinking that applies to technology and innovation applies to scaling, which takes technologies and innovations as the object of scaling, even more so as scaling processes move technologies to new scale levels and often to new domains and contexts (we explore this further in Chapter 3).

Giddens and Beck argue that although humans have always been subjected to a level of risk – such as natural disasters – these have usually been perceived as produced by non-human forces. Modern societies, however, are exposed to risks (from innovations at scale) that are the result of the modernisation process itself. Giddens (1999) defines these two types of risk as external risk and manufactured risk. Manufactured risk is marked by a high level of human agency involved in both producing and mitigating such risk. For Beck (1992), modernity is a world that introduces global risk parameters that previous generations did not have to face. Precisely because of the failure of modern social institutions to control the risks they have created, such as the ecological

crisis, risk rebounds as a largely defensive attempt to avoid new problems and dangers (Elliot, 2002), which is what the risk society is about (Beck, 1992).

Technologies are not just value-neutral tools. They are part of an outlook on life, and the underlying motives of technological practice are about more than just making life a little easier (Schuurman, 2005). There may be no way out of a world with technology, but it is necessary to be aware of what it does to us exactly and how we use it (Habermas, 1992). Marcuse (1964) and Ellul (1964) go further by considering technology as a problem in itself. Technology and its development are generally considered to be motivated by an underlying paradigm of economic growth backed by an ideology, usually identified as capitalism (see Box 2.3). According to Habermas (1992), the core problem is that such growth is not subject to guidance or control. Implications of this include the loss of community and human interaction as the essence of society, where society has become rather focused on work, achievement, and returns on investment (Harvey, 2003).

Box 2.3: Concerns about the technologisation of society and life

Jacques Ellul (1964, 1990) criticises what he calls an obsession with efficiency and a widespread tendency to give answers in the form of 'solutions' (currently mostly framed as innovations) before, he states, even properly understanding what we are dealing with, and addressing problems caused by technology by so-called solutions coming from new technologies. Technology assessment is a common approach, but he asserts that the systems that drive the development of technologies are rarely called into question. He refers to technique (technology) as the search for the "one best way" (Ellul, 1964:12) in which technology is not just about the technical but includes all means. He challenges assumptions such as that made by Simon (1981) that "there is no necessity either in logic or in historical trends to suggest that the supply of any given resource is 'finite'" (quoted in Ellul, 1986:21) and that there is no need for fear regarding food supply because new technical inventions will at least double production. One of the key concerns, according to Ellul, is that it is not just about how technology is used, but also that it "carries with it its own effects quite apart from how it is used" (:34). He accuses it of diverting focus from the essence of society, which according to him is life and communion, towards that which can be technicised. Schuurman (2009) ascribes such effects to making certain aspects of experienced reality an absolute (notably the quantitative and physical); this comes at the expense of not doing justice to other aspects (such as the biological, social, and ethical). Ellul argues that this is supported by a "bluff" involving the exaggeration of effective possibilities through technology and the "radical" concealing of negative aspects (Ellul, 1986:xvi). It gradually changes the whole fabric of society (see also Marcuse, 1964), and social costs of the ever-expanding deployment of modern technology in the production process are virtually ignore by modern economists (Goudzwaard & de Lange, 1995).

Goudzwaard et al. (2007:20) identify a solution paradox where "solutions themselves often either intensify the problems they were intended to solve or create new and even more serious problems. Too often, the cure is worse than the disease". These authors give examples in relation to the distribution of wealth and poverty, security, the

environment, and financial markets. They conclude that "advanced technologies still do improve health, enhance crops, clean the environment, increase modes of communication, and develop faster means of transportation. But the problems they often leave in their wake – genetic risks, an overabundance of information, rising addiction, more stress and burnout in the workplace, the poor without access to agricultural production, and enormous growth in the means of mass destruction – are often more serious and more obstinate than the problems they solve" (:24–25). Yet the autonomy of technology, science, economy, and finance expands. How come? Goudzwaard (1981) considers this to be the effect of obsession, of putting all hope in them. They become idols, gods to save the people (see also Smith, 2016). In the past, people made gods of wood, gold, earthenware, and so on. With secularisation, such worship has not departed the West. Rather, different gods came in their place. "As soon as people put themselves in a position of dependence on their gods, invariably the moment comes when those things or forces gain the upper hand, when they begin to mould the lives and thoughts of their adherents" (Smith, 2016:27; see also Marcuse, 1964), becoming powers of domination (Goudzwaard et al. 2007).

Schuurman (2005, 2010) and Ellul (1964, 1990) argue that it does not work to assess only later whether effects are acceptable, as this would mean letting technology shape our ethics, our ideologies, our understanding, our preferences (see Box 2.4). Starting to use a technology is about more than pragmatism. It shapes and changes people's outlook on life. And then there is no way back to the original, wise, perspectives from before the introduction of the technology (Ellul, 1964, 1990).

Box 2.4: Technology changing people and their ethical dispositions

Schuurman (2005, 2010) and Ellul (1964, 1990) argue that technology changes ethical perspectives and that ethical perspectives are influenced by the very use of technologies. As people start using particular technologies, their original ethical dispositions tend to change as a process of habituation and acculturation. This involves sliding scales and a gradual and unconscious shift in ethical thinking. Ellul and Schuurman consider this as a numbing of the ethical senses along the lines of the parable of frogs in water that is brought to a boil. Marx and Smith (1996) speak of "an invention, once introduced into society", taking on "a life of its own" (quoted in Hess, 2015:121).

In light of issues such as those raised, Bloom and Ainsworth (2010) argue the need for a new politics of innovation that would not be about being 'pro' or 'anti' science or technology, but about addressing questions such as, 'what technology and why?', 'whose innovation?', and 'what kinds of change?'. They raise the issue of connecting innovation to achieving greater social justice involving a diverse, balanced, and distributed approach to innovation involving a wider sense of ownership and empowerment (Holden et al. 2017; STEPS Centre, 2010).

2.3.2 The model orientation

The scaling innovations for progress and development approach is model-based in two ways: 1) it involves innovations as models to be scaled and 2) the scaling of innovations as such is a model (mechanism) for achieving progress and development. We discuss the model-based nature of the approach from these two angles.

Scaling innovations involves models of development and progress, particularly models that are considered to work (Cohen & Easterly, 2009). In relation to each of the processes described in section 2.2.2, we can identify underlying models or ideal types. And these models relate to scales. For example, in the case of industrialisation, one key model would be large-scale production facilities. Practices, or even whole countries, can then be located on a scale that reflects the extent to which production is taking place in line with the model. In a way, one could say that following the model as a path to progress of necessity breeds homogenisation (McCloughan, 2003). A model is about a 'how to', for which reason models abound in the literature on innovation. The idea of best practice is closely related to this. Models are continuously being invented and succeed one another. At the same time, these models are regularly criticised (Godin, 2015). Calling a conceptualisation or narrative or tool a 'model' facilitates its propagation (Godin, 2015), and this confirms how the process of scaling in development and progress is all about models. The literature on scaling is often about innovations (inventions) that become models to be scaled (Godin, 2014); these may be products (a success model), practices (a model farm), or policies (model behaviour). Theories are also a form of model, including theories of change.

Models are a way of dealing with complexity and differences in perspectives, proving a basis for control and collaboration. A model, by its nature, reduces complexity to something that can be handled and agreed on, but doing so ignores its social and environmental embedding. Scaling up (development) models is attractive as it:

- Delivers efficiency gains: there is no need to 'reinvent the wheel'
- Enhances control over process: there are more opportunities to manage change processes
- Streamlines efforts to enhance efficacy: multiple efforts are working in unison
- Provides standards for evaluation: this provides clarity on what is to be complied with
- Provides opportunities for quick feedback processes: it provides a clear reference framework for learning.

Innovation models have also been developed to frame and guide policies for economic growth. Such models have become central in innovation rhetoric (Godin & Vinck, 2017). Models in terms of assessment methodology have a tendency to be used for political purposes and debates when interpretations of findings exceed what those

findings support. An example of this is the debate on conventional versus organic agriculture. Depending on what is considered (which variables are in the model), one may draw different conclusions. For example, Kniss et al. (2016) report lower yields from organic agriculture as compared to conventional agriculture, acknowledging that this does not provide a sufficient basis to make general statements about which one performs best as it does not take into account all possibly relevant factors. The soil life dimension of the issue is often not taken into account. Lori et al. (2017) conclude that organic farming enhances total microbial abundance and activity in agricultural soils on a global scale, showing how crucial it is to understand what is and is not part of an assessment model. Models can therefore be misleading. In 2017, Dutch citizens were surprised by the way Schiphol airport handles noise[8]. According to this report, noise levels were not measured, but rather calculated on the basis of models that e.g. overstate absorption of noise by the soil. This was a clear illustration of the basic fact that models are only as good as the premises and data upon which they are based, and it is also an example of how models can become a replacement for reality.

Scaling innovations for progress and development is about scaling successful development and innovation models (Cash, 2011; Chandy et al. 2012; Cooley & Kohl, 2006; Ezekilov, 2011; Gradl & Jenkins, 2011; Pachico & Fujisaka, 2004; Steele et al. 2008). This may apply to business models, to agricultural practices (innovations), to institutional arrangements and systems, to technical inventions and technologies. The underlying development formula appears to be: good models + good scaling = good progress.

The technology transfer approach is a typical example of a model that aligns closely with the idea of scaling innovations for development and progress. Innovation became part of a linear concept of modernisation through technological change: technological products and services were developed by researchers and other experts and introduced to practices deemed in need of such technology. This is where the idea of technology transfer was born, and it became a widespread model for agricultural development (ICHRP, 2011; Sampath & Roffe, 2012; van der Stoep & Strijbos, 2011). In the following, we briefly explore a variety of implications of the model orientation of the scaling innovations for development and progress approach.

Models lead to outcomes in line with their nature

Models do not only bring solutions. If the model brings both good and bad outcomes, applying it cannot be expected to lead to different outcomes, so bad outcomes will persist. And if those are seriously negative outcomes with cumulative effects (e.g. climate change), it is a risky business to hold on to the model even if there are also

[8] http://www.dutchnews.nl/news/archives/2017/10/airport-noise-miscalculation-means-schiphol-effects-to-be-looked-at-again/, accessed 10 January 2018.

positive outcomes. Hendrickson and James (2005) discuss how scaling in terms of the industrialisation of agriculture creates dynamics and conditions that force farmers in directions in which they actually do not want to go. It not only alters the ways in which agricultural production occurs, but also impacts the decisions farmers make consequent to reduced options available to them.

Models applied at scale lead to vulnerability

When one farmer adopts a particular model (mode/style) of farming, that is only natural. One has to make selections and focus. However, if a thousand farmers adopt that same model, it becomes a completely different issue. Not only will it work out differently because of the different contexts in which the model is applied (the model usually involves a one-size fits all process), it concentrates risks and thereby reduces resilience (option of switching) and an ability to handle complexity of contexts and unanticipated processes and events (Bannerjee & Duflo, 2012; Smart, 1999; Stirling, 2009; Norberg & Cumming, 2008).

Models are rooted in culture and paradigm

In section 2.2, we discussed the models of development in the last century, which were strongly based on Western models. Models are born from within a particular culture (what is considered important and appropriate) and paradigm (how things are thought to work, including related theories of change) (Visser, 2010; Hobart, 1993; Friedrich-Freksa, 2004).

Models breed power

The person who develops a model may derive benefits from this for various reasons, such as that it is tailor-made to designer preferences, but the designer will often also know best about the implications and can anticipate these (see e.g. discussions on GMOs). Also, the designer (or proposer) of a model will often be involved in setting the rules on how to comply with the model. Scaling models implies a certain degree of copying, of replicating, of standards in order to ensure that more of the same is obtained. This necessitates a certain measure of compliance. Another power issue is how much freedom there is to change the model or even refuse the model. This is a relevant question in the context of international development where those who control the funds for development may to a large extent set the rules (Page, 2008; Oxfam, 2009; Kuonqui, 2006; Max-Neef & Smitth, 2011; Basu & Kanbur, 2009; Boym, 2012; Sen, 1999; Schumacher, 1973; Deneulin & Shahani, 2009).

Models simplify and are a reduction of reality

This is a key reason for developing models, as it creates (at least a sense of) control. However, forgetting that the model is indeed a reduction of reality leads to models

being used to guide processes that deal with a reality that is much more complex and rich. That same reduction in perspective holds an inherent risk of rigidity and loss of diversity, particularity, individuality, and unique identity. Uniqueness and originality are invaluable, and, the moment a model is scaled up, it has lost its essence. Nature thrives on diversity and so does society (van der Ploeg, 1993; van der Ploeg & Long, 1994; Hubbard, 2004; Evans et al. 2010; Reeves, 2005; Anheier & Raj Isar, 2007, 2010; Tierney, 2007).

Models have the tendency to become blueprints

Blueprint approaches have been criticised in the past but are a natural consequence of the model orientation of scaling innovations. Technocrats and administrators like blueprints because blueprints make their lives easier as they can use a standard assessment method. Blueprint methods, however, neglect the role of bottom-up approaches that emphasise local contexts and local innovation. Scaling up is in this way predominantly conceived as a technical exercise following a linear trajectory from innovation to standardised intervention design, implementation plan, and implementation. Critics of blueprint approaches have pointed out that scale-up plans frequently fail in the face of complexities and uncertainties on the ground (Constantides & Barrett, 2006; Peters et al. 2009; Subramanian et al. 2010).

We conclude that not only does the model orientation of the scaling innovations for development and progress approach relate to all the limitations of models in general, but also that the process of scaling exacerbates associated risks and vulnerabilities.

2.3.3 Associated distortions

In the previous two sections, we discussed origins and implications of scaling innovations for development and progress. In this section, we dig deeper into what scaling processes actually imply, for a moment forgetting about the link to models and innovations. Each discipline has its own particular scales by which relevant phenomena are characterised and different processes that are referred to as scaling. The importance of appropriately understanding the implications of scale and scaling have been discussed by many (e.g. Cash et al. 2006; Cumming et al. 2012; Gibson et al. 2000; Häyhä et al. 2016; Wu et al. 2006). Inappropriate handling of scale issues may cause all kinds of problems such as when there is a focus on just one type of scale, e.g. just looking at size or speed, while other scales (environmental impact) are neglected; or not considering that processes (and associated change) occur at different rates/speed (annual crops grow faster than trees) or at a different frequency (outbreak of disease) or period of occurrence (rainfall). Processes may happen in one place (space) and not in another. Processes may occur in non-linear ways, which may involve tipping points (Scheffer et al. 2009; Scheffer, 2010). Also, whether something

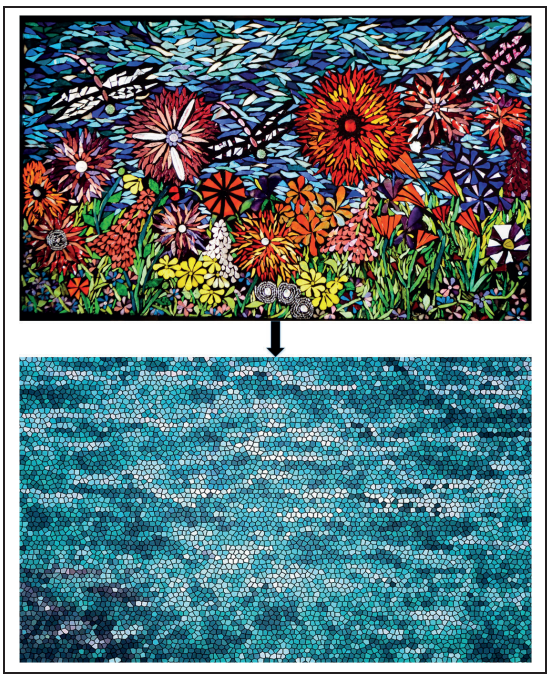
is a local issue or a global issue makes a difference. So, the scale at which a particular issue needs to be addressed is important (Padt et al. 2014). At the same time, one must be careful not to reduce this to the scale at which issues occur. Climate change is a global issue, requiring both global attention and local action.

We now discuss examples of types of disruption that the scaling of innovations may cause in order to illustrate how deeply related processes may impact society. This is generally not given much thought, but doing so provides ideas not only about implications, but also about how these may be anticipated.

Selective scaling

Selection is a necessary process in life. Farmers have to choose, for example, the crops that they will grow. Selection at scale introduces a new dynamic. If all farmers in a region choose the same crop, this results not just in monoculture, but monoculture at scale (see Figure 2.1). From a narrow economic (economies of scale) and technological point of view, this may make perfect sense; but a broader view, e.g. including an ecological rationale that points out multiple environmental hazards associated with monoculture, puts it in a different perspective (Uekoetter, 2011).

Figure 2.1: Illustrating implications of selective scaling (linking to concepts such as McDonaldisation and monoculturalisation)



Source of top picture: "Secret Garden" by Kory Dollar, https://marvelousmosaic.wordpress.com/
Used with permission

Source bottom picture: https://pixabay.com/en/mosaic-stones-glass-pattern-1074931/ , freeware

Research may advance faster if scientists concentrate all their energy on one crop – but that implies that the knowledge base may become narrow over time, increasing vulnerability and decreasing possibilities of shifting to new crops when necessary (Uekoetter, 2011). Landraces are connected to the specifics of the (soil) environment. That connection has been cut in industrial agriculture and in the research focus on limited crops and their varieties, and the associated monoculture (Visser, 2010). The use of food crops for biofuel is a typical example of not

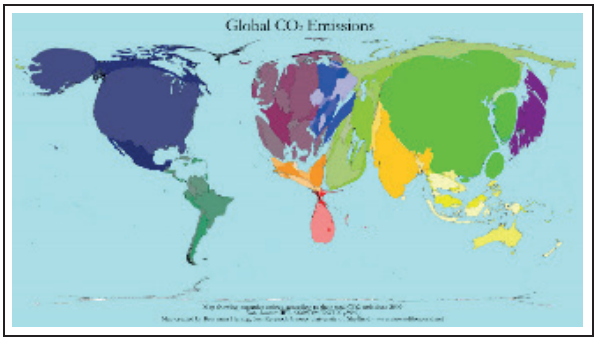
paying attention to what happens when features are taken out of context (Matondi et al. 2011).

Asymmetric scaling

The concept of scalability (of innovations) is often understood as being about disproportionality where the idea is that scaling of capacity will be coupled with less than proportionate scaling of required inputs (the efficiency argument or economies of scale) (Davies & Simon, 2013). In the following, we briefly explore some other distorting effects of disproportionality associated with scaling innovations.

Access to, and use of, innovations will be different for different groups of people (countries, localities), but the associated effects of using innovations will also be different (see Figure 2.2). Furthermore, the focus of scaling initiatives will be on appreciated outcomes, often disregarding side-effects. Visser (2010) explores agriculture-related side-effects related to intangibles and hidden tangibles such as the severing of the connection between the farm(er) and local communities, local soil, and local ecology. This includes the implication of scaling up farm size, and the resulting decimation in the number of farmers also means a severing of farms' historical roots. Other hidden distorting effects in agriculture include the consequences of scaling up the use of NPK chemicals (particularly N) for soils and soil fertility that have remained hidden although they may be as bad as the more tangible effects of carbon emissions on the climate (Montgomery, 2017; Visser, 2010).

Figure 2.2: Illustrating asymmetric scaling (global CO^2 emissions in 2009) (Hennig, 2009)



Excessive scaling

Excessive scaling is about the distortion of proportions, which is also framed as overshoot (e.g. Häyhä et al. 2016; Raworth, 2017; Scheffer, 2010). Excessive does not necessarily mean large in quantity. What is medicine in a tiny amount can be poisonous even in small amounts. In nature, scaling is more or less controlled by mechanisms (scaling laws) that maintain e.g. populations within a particular range, thereby safeguarding proportionality (e.g. West, 2017). So, this is not about stable equilibria (Scheffer, 2010) but about a dynamic and about harmony as long as conditions are not disrupted from outside. People have a tendency to disrupt such

dynamic harmony through scaling processes, leading to situations that are irreversible or very hard to reverse (Scheffer, 2010). This is not just about ecology, but also about society. Once a society becomes hooked to material prosperity, it will be hard in a democracy to make people content with less than that to which they consider themselves entitled (Ellul, 1990). The Dutch expression *de wal die het schip keert* (the embankment turns the ship) becomes relevant. It refers to situations where people will only change their behaviour if they get stuck and are confronted with consequences of their behaviour. In other words, societal change, particularly in a democracy, is often only possible when warnings about consequences have turned into experienced negative consequences (see Figure 2.3).

Figure 2.3: Illustrating excessive scaling (impact at scale when the Aral Sea was drained as a result of irrigated agriculture going to scale)

Picture source: www.nationalgeographic.com.
For more detailed discussion, see
http://ngm.nationalgeographic.com/2015/06/aral-sea/synnott-text

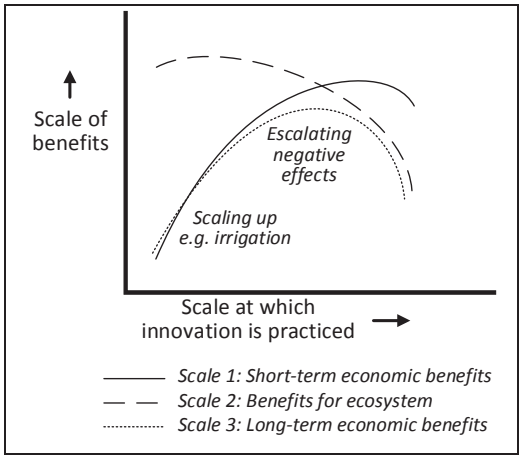
We do not have the space here to discuss other implications, but we do want to point briefly to one typical implication, which is that scales are connected (see Figure 2.4). Scale up one thing, and something else will generally scale up or down simultaneously and/or consequentially. It is important to understand which processes will start dominating at what scale. At what scale will complexity start to obscure primary practices and processes? What governance mechanisms are in place to guide this appropriately? If more farmers grow a new crop, they will be growing less of certain other crops, unless they start using more land. However, even in the latter case, they would be reducing certain vegetation more often than not. If we scale up the use of fossil fuels, emissions also scale up, while at the same time reserves fall. Arguably, there could be examples of win-win situations, e.g. when the use of hydropower replaces the use of firewood (trees), but generally somewhere a loss will be identified, such as e.g. fish stocks in the case of irrigation.

Other forms of disruption caused by scaling innovations

Human activity almost by definition distorts balances, and this is hard to prevent. It remains crucial, however, to understand when (at what level) such distortions become seriously problematic. By its nature, the scaling innovations for development and progress approach involves de-contextualisation, which generally does not involve

finetuning, gradual adjustment, organic integration, adaptation, or co-evolutionary process, but rather a process often framed as 'rolling out' (Tiggelaar, 2012). Innovations are identified and selected in a particular context and then taken to new contexts. Testing and piloting is an attempt to overcome associated limitations, but there will always be an end to this, after which the leap (roll-out) of scaling follows.

Figure 2.4: Excessive scaling. A simplified (qualitative) perspective.



Disruptive innovation is hailed by some as the way to make necessary transitions in sectors and society possible[9]. Indeed, we sometimes need to break out of straightjackets and constraining patterns. The disruption part is in fact all about scaling. Little will be disrupted if only a few farmers adopt a new practice, but more may be disrupted than realised (Box 2.5). This points to the need for sufficiently comprehensive perspectives to be able to better anticipate what may be disrupted in the process of scaling innovations.

The above three types of potential implications of scaling innovations are not an exhaustive list. In Chapter 3, we discuss interactive scaling in terms of a multitude of ongoing scaling processes with which the scaling of a particular innovation interacts. We may also think of provocative scaling in terms of an action–reaction dynamic where scaling may start a chain reaction. If a farmer scales up the area planted with one particular crop (selective scaling), that may attract particular pests and diseases, which may make the farmer scale up the use of pesticides, which in turn affects biodiversity such as (beneficial) insect populations (see Hallmann et al. 2017), and so on. Another way of framing this would be to speak of irrespective or undifferentiated scaling, which would be about a uniform roll-out of e.g. an innovative new product, which may trigger different types of responses and effects according to specific characteristics of different groups and different localities.

We briefly explored different types of potential shifts in natural and social conditions resulting from scaling innovations. They are partly overlapping in nature, and one situation of scaling innovations may involve more than one type of shift. The essential take-away from this section is that scaling may often set in motion more than was

[9] E.g. see blog by Marticorena, D., 2017 on A Disruptive Time for Agriculture. http://blog.awhere.com/a-disruptive-time-for-agriculture

meant or even anticipated (we explore this further in Chapter 3). Trade-offs will be involved, but, in a globalising context, it will be increasingly difficult to comprehend and anticipate effects of a multitude of initiatives aiming to scale innovations. Van der Ploeg (2008:11) makes the sobering observation that the "many-faceted and internationalized agrarian crisis increasingly represents a Gordian knot in the sense that alleviation of one aspect at any one particular moment and place only aggravates the crisis elsewhere at other moments and/or transfers to other dimensions".

Box 2.5: Illustrating disruption and the loss of control over effects of scaling production

Early in 2018, an earthquake hit the Dutch province of Groningen. It was not the first time. The correlation between earthquakes and natural gas exploitation had been established earlier, and models were developed to predict the relation between the level of natural gas exploitation and the incidence and magnitude of earthquakes in this province. On the basis of these models, the amount of natural gas extracted was reduced significantly. The expectation was that, from then on, earthquakes would occur less frequently or at least be of a lower magnitude. This turned out not to be the case. A lead expert stated that it had now become unclear how exactly earthquakes in Groningen are caused and that things have been set in motion that seem no longer to fit in existing (predictive) models[10].

2.4 On narratives supporting ambitions to scale innovations

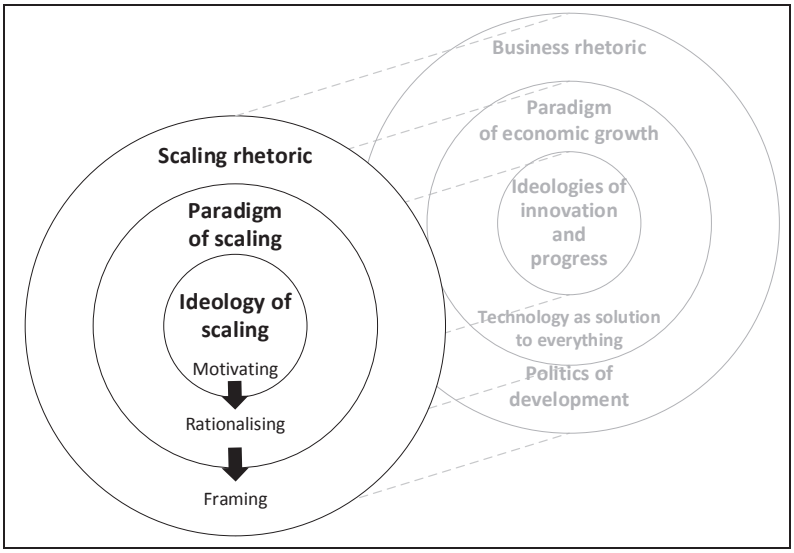
In the previous sections, we traced some of the origins of ideas and processes that gave rise the popularity of scaling innovations, we considered how scaling processes are part of formation processes in society, and we explored a number of inherent implications of scaling innovations. We now turn to what motivates, rationalises, and frames the case for scaling innovations for development and progress, considering this in light of wider societal rationales and motivations. We do so along three interconnected lines: scaling as rhetoric, scaling as paradigm, and scaling as ideology (Figure 2.5), where each section takes a step deeper into the world behind the scaling innovations approach. In this, we are not asserting that everyone involved in scaling innovations will subscribe to that same rhetoric, paradigm, and ideology. However, we would argue that people, by using a term charged with rhetoric, paradigm, and ideology, may be unwittingly drawn into a narrative of which they actually do not want to be part.

2.4.1 From rationale to rhetoric

The core narrative we discuss here is: 'scaling innovations solves our challenges'. We may frame this as *scaling bluff* (along similar lines as Ellul talks about technological bluff) and as part of development-related buzz words (Cornwall & Brock, 2005).

[10] http://www.dvhn.nl/groningen/Geoloog-De-gaskraan-dichtdraaien-is-niet-meer-de-oplossing-vrees-ik-22803689.html, accessed 11 January 2018.

Figure 2.5: Uncovering what is behind the scaling innovations for development and progress approach



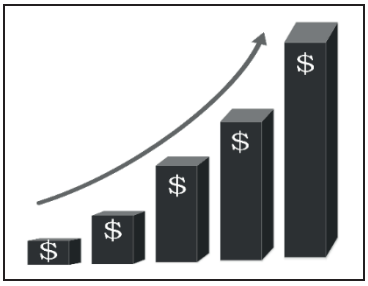
Scaling bluff is about the promise of solutions to problems and about the continued expansion of possibilities. Ellul concluded that many successes and exploits are ascribed to techniques (without regard for the cost or utility or risk), because technique is regarded a priori as the only solution to collective problems (such as unemployment, Third World misery, pollution, war) and individual problems (health, family life, even the meaning of life). At the same time, it is seen as the only chance for progress and development in every society (Ellul, 1990). The same type of arguments that Ellul challenged are now used in the argument made for the need to take innovations to scale (e.g. Ezilov, 2011).

Scaling rhetoric can be expressed in many different ways. It involves the assumption that scale is good, such as in "*Overcoming Barriers to Scale"* (Gradl & Jenkins, 2011). Turrell & van Dijk (2014:4) state that "for us, therefore, scaling is the achievement of outsized results through small smart moves, aided by good fortune". Scaling is expected to make all the difference in relation to global, national, and local challenges. All we are asked to do is to "change pace (…) to scale and accelerate (…) towards vision" (also see Fussler, 2012). Chester, 2005:1 reports that "achieving 'scale' in behavior change and/or the adoption of new technologies has long been the desire of international development practitioners". By scale, he then means adoption of new behaviours or technologies by the thousands, or even tens of thousands; but, he laments, "scale has remained elusive for much of the agriculture and natural resource sectors" (Chester, 2005:1).

In arguments for the importance of scaling innovations, usually the economic argument is used to promote the scaling of technologies that involve increased vulnerability, while neglecting concerns found in the social and/or environmental (Ramani & Thutupalli, 2015). Scaling rhetoric is very much about framing alleged

solutions to challenges as evidently requiring not just scale, but essentially also replication whether in slightly adapted form or not (van Lieshout et al. 2017). This also involves framing the scale at which challenges need to be addressed or at which visions need to be pursued, which may include what actors and ideas are and are not included (van Lieshout et al. 2011). Critical voices then tend to be ignored to keep the ranks of rhetoric closed (e.g. McIntyre et al. 2009). Those who argue against scaling innovations are sometimes accused of being immoral[11]. It is part of technology and scaling rhetoric. Scaling rhetoric in relation to scaling innovations for development and progress closely resembles business rhetoric, which is generally phrased as 'find out what works and do more of the same' (see Figure 2.6). This needs to be balanced, though, with the observation that scaremongering can also be part of an anti-technology and anti-scaling rhetoric (Giddens, 1999).

Figure 2.6: Typical illustration of business rhetoric on scaling



A common focus in the business sector these days is to move from start-up to scale up. "Europe has no shortage of successful entrepreneurs and innovative ideas. (…). The problem, however, is that European companies seldom grow to scale" (Hofheinz, 2016:3). The World Economic Forum goes as far as stating that start-ups will not save the economy; but scale ups could as they "demonstrate quick growth"[12]. Scale is everything in business, and this has infused scaling rhetoric in relation to scaling innovations for development and progress because politicians have embraced the private sector as holding the key to sustainable development. The problem is that corporations will generally prioritise private goods over public goods (Jackson, 2016), and those producing chemical implements such as pesticides and fertilisers have a vested interest in seeing sales of the same go to scale (Visser, 2013). And this is perhaps the major issue with scaling rhetoric: proponents usually have vested interests in seeing innovations go to scale, either because of business interests, or because of interests in securing grand funds for (research for) development in return for which they give the promise of impact at scale, where the values that are obscured have no clear defenders.

2.4.2 From paradigm to paradox

In this section, we dig one step deeper towards that which supports scaling rhetoric. The core narrative we discuss here is: 'scaling innovations is good'. We may frame this as the *pro-scaling bias* (along similar lines as the previously mentioned concept of pro-

[11] http://reason.com/blog/2017/12/28/gmo-opponents-are-immoral-argues-purdue, accessed 16 January 2018.
[12] (https://www.weforum.org/agenda/2017/03/start-ups-entrepreneurship-scale-ups-latin-america/).

innovation bias (e.g. see a related critique by Gripenberg et al. 2012; Sveiby et al. 2012). The pro-scaling bias is about efficiency as best practice and best practice as the blueprint to be applied at scale. From our explorations reflected in sections 2.2 and 2.3, we consider the scaling innovations for development and progress approach to be an essential part of the paradigm of economic growth. The paradigm of perpetuating economic growth has been critiqued by many as an economically and environmentally unsustainable and morally undesirable approach (e.g. Daly, 1992; Smith, 2016, Goudzwaard & Bartholomew, 2017). Goudzwaard et al. (2007:28) argue that "for years in Western society we have seen unhampered, maximum economic growth as *the* prescription for achieving greater material prosperity. This pursuit has made us wealthier, but also more vulnerable. (…) Intensive global competition now almost compels industrialized societies to pursue the vigorous, uninterrupted growth of their gross domestic product. (…) If unbridled competition obliges us to pursue the cheapest possible production costs regardless of the consequences, then we shift production overseas to places of cheap labor and inadequate standards for employees and the environment. (…) Obsessed by an end (rising material prosperity), we have off-loaded our responsibility and allowed various forces, means, and powers in our society (such as untrammelled economic expansion) to become gods who dictate their will to us". These are no small words, but Goudzwaard et al. are not the only ones who vehemently oppose the paradigm of ever-perpetuating economic growth (e.g. Meadows, 1973; Daly, 1992; Jackson, 2016). If indeed the scaling innovations for development and progress approach is part of such a paradigm, it should attract a similar critique, which indirectly it may do, but, as reported earlier, the scaling innovations approach is not targeted specifically.

In sections 2.2.3 and 2.3.3, we explored reasons for considering the scaling innovations approach to be based on vulnerable foundations, running the risk of causing all kinds of distortions, mismatches, disparities, and imbalances. This relates closely to the discrepancies that Goudzwaard & Bartholomew (2017) observe in modern society, which they frame as the solution paradox (Table 2.2). In the midst of the promise of bringing solutions, the economic growth paradigm has caused negative impact as well (this relates particularly to the Global West).

Table 2.2: The solution paradox (adapted from Goudzwaard & Bartholomew, 2017)

Paradox	Description
The poverty paradox	Rising poverty in the midst of wealthy societies
The care paradox	Diminished opportunities to provide care for others despite higher disposable incomes
The time paradox	Unprecedented pressure on our time despite unparalleled wealth
The employment paradox	Structural unemployment in the midst of an expanding economy

The environmental paradox	Environmental challenges (e.g. climate change) growing out of control precisely when we possess an unprecedented ability to address them

Scale, economies of scale, and economies of size are presented as an allegedly proven recipe, but they involve several unproven assumptions. Essentially, this depends on what is made part of the equation and what is not. Duffy (2009), for example, found it debatable whether economies of size would exist in agricultural production if all costs were accounted for. So, this is about core assumptions regarding how change happens and which assumptions are made explicit and which are not. Jones (2009) argues that, if one considers the costs of economic growth such as pollution, global warming, eradication of insects, animal, and plant species, and so on, it cannot be considered a successful paradigm. From a systematic review, Loevinsohn et al. (2013) report that there is no clear evidence on the conditions and circumstances under which farmers achieve productivity gains when they adopt technology.

Goudzwaard & Bartholomew (2017:228) argue that "most decision makers still deal with these [issues] as separate problems. Each crisis receives its own package of targeted solutions. Very seldom are the proposed remedies connected with each other. Some solutions are repeatedly adjusted to fit a longer time range" "(…) the solutions offered usually restrict themselves to financial, fiscal, organizational, or technological interventions. The accepted political solutions are the input of more money or more technologies or the creation of new markets – standard solutions offered by the classical modern worldview. Whatever their more superficial variation, this appears to be the unvarying prescription. Clearly, the fundamental assumption is that each problem, each kind of crisis, can be cured by these available solutions". In relation to agricultural transformation, Röling (2009) therefore argues that it is not a mere matter of improving models but also reconsidering paradigms and mind-sets" (also see Röling, 2011).

In this and the previous sections, we explored how scaling innovations leads to all kinds of distortions in nature and society, some of which are highly undesirable, at least contested, and sometimes in a long-term perspective overshadow and outdo any positive effects (notably climate change). Goudzwaard & Bartholomew (2017), discussing the paradoxes of progress and development, highlighted the unwavering trust in economic growth and the possibilities of progress, which we connected to the scaling innovations for development and progress approach. This points to an a priori legitimisation of a paradigm and rhetoric of scaling innovations despite associated negative outcomes. Therefore, there must be an underlying ideology of scaling: a faith in 'putting the foot on the accelerator' of progress and development once more in a (last?) effort to speed up to escape an 'erupting volcano' of consequences of earlier scaling of innovations ("Ideology is justification", wrote Theodor W. Adorno, quoted

in Goudzwaard et al. 2007:209). We therefore take another step in unravelling the roots of the enthusiasm for scaling innovations and related high bets that are put on its alleged potential to address the scale of challenges facing humanity, which may be typified as 'scalicism'.

2.4.3 From idea to ideology

The core narrative we discuss here is: 'in scaling innovations we trust'. We may frame this as the *scaling belief*[13]. Scaling belief is about the politics of progress to sustain power and vested interests. In our introduction, we quoted some authors who represent such trust in scaling as the key approach for addressing the grand challenges and as the only way to keep pace with the growing gravity of such challenges (e.g. Hughes et al. 2013; Jochemsen, 2015). The underpinning reasoning is that a growing population with its increasingly competing claims on natural resources and its disproportionately growing ecological footprint can only be matched by a growing economy coupled with ever more sophisticated technologies. This is a core narrative underpinning ambitions associated with scaling innovations for development and progress, which links to wider narratives. Making a case for the existence of an ideology of scaling is but a small step from what has been written about the ideology of progress (e.g. Goudzwaard & de Lange, 1995), the ideology of innovation (e.g. Godin & Vinck, 2017), the ideology of technology (e.g. Schuurman, 2009; Ellul, 1964), and the ideology of development (e.g. Cowen & Shenton, 1998; Easterly, 2007; Sutton et al. 1989). Hardemann & Jochemsen (2012) develop this line of thinking when considering ideological aspects of the modernisation of agriculture.

Box 2.6: Ideology needs no evidence

> Visser traces back critiques on capitalism, which is associated with growth thinking, to Paul Lafargue's *La religion du capital* (1887) and to Chesterton's *Outline of Sanity* (1926), from which he quotes: "they committed their people to certain new and enormous experiments; to making their own independent nation an eternal debtor to a few rich men, (...) to driving food out of their own country in the hope of buying it back again from the ends of the earth" (quoted in Visser, 2013:40). This is not about evidence-based practice, but about ideology that has the power to legitimise nonsensical policies.

We may understand ideology as the entire set of conceptions and beliefs subscribed to by a specific group of people. According to this definition, everyone has an ideology of one sort or another (Goudzwaard et al. 2007:32). Basing this on the French philosopher Destutt de Tracy's work on ideology, "we can extrapolate three elements that, combined, define the classical concept of ideology. First, ideology consists of an absolutized political or societal *end* (goal). Second, ideology requires a *redefinition of*

[13] As the acceptance of, or reliance on, the scaling innovations approach and its usefulness in different settings and processes (adapted from Kidd, 2009).

currently held values, norms, and ideas to such an extent that they legitimize in advance the practical pursuit of the predetermined end [see also Box 2.6]. Finally, ideology involves establishing a standard by which to *select the means* or instruments necessary for effectively achieving the all-important goal" (Goudzwaard et al. 2007:33). "Genuine ideologies always try to seize control of an entire society" (:34). Goudzwaard & Bartholomew (2017) further explore the redefinition part of ideology (see Table 2.3: they explore seven categories of which we show only three). Such redefinition is also a way to back itself up. Any challenge to the ideology can be redefined so as to take the sting out of it.

Table 2.3: Ideologically motivated circular reasoning (adapted from Goudzwaard & Bartholomew, 2017)

Step 1: Modernist redefinition of needs and desires ➔			
Human needs and desires	***Modernist redefinition***	***Ideologically legitimised means*** *(options for scaling)*	***Actual (paradoxical) outcome***
Happiness	Increased material wealth	Economic productivity	Unemployment, environmental problems, stress
Care (social)	Organised welfare	Efficiency, productivity, GDP growth	Increasing need for care, increasing inability to pay
Health	Longer and better life	Pharmaceutical technology, genetic research	'Prosperity' diseases, overuse of medical means
			← Narrative of progress and development: Step 2

As Goudzwaard & Bartholomew (2017) note, this table indicates tendencies only, and it is not meant to suggest monocausal relationships. It illustrates origins of incongruities in rhetoric, paradigms, and ideologies underpinning change processes in society. The inherent socio-agronomic problems of intensive monoculture, for example, are reified as genetic defects, which therefore must be corrected at the molecular level (Levidow, 1998). Within its self-perpetuating logic, any limit or failure must be remedied by more of the same solutions (see also Vanloqueren & Baret, 2009, who discuss the effect of technological regimes). Figure 2.7 further visualises related dynamics.

In this light, the call for institutional innovation to match or complement opportunities for technical/technological innovation (Schut et al. 2016) needs to be approached with caution, as it may be merely serving the paradigm of economic growth and the ideology of progress. As stated, everyone has an ideology of some sort. The problem with ideology is that its underpinning ideas may become absolutised and an idol. And subsequently, idols may become demons, as Ellul (1997:177) observes, "What is tragic is that once a thing has been transformed into a divinity, technique for

example, we are ready to sacrifice persons to it", including future generations being on the receiving end of what previous generations have set in motion, such as climate change (Toly, 2005).

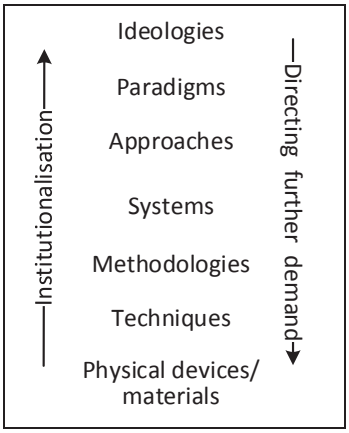


Figure 2.7: The self-replicating interaction between innovations and ideologies

2.5 Rethinking scaling ambitions

We have demonstrated why there are many reasons to be very cautious about scaling thinking and practice. The common part in narratives of scaling innovations may be represented, ironically, as 'in order to make progress (ideology part), we have to scale (up) innovations (paradigm part), so we need to massively scale up solutions to known problems (rhetoric part)'. It is a package deal. We argue for a serious reconsideration of dominant patterns in the thinking and the practice of scaling innovations for development and progress. For too long, this has been approached too uncritically. In the following, we briefly explore three ways in which to change the discourse on scaling innovations: resisting related bluff, rebalancing related bias, and reconsidering related belief.

We focus here on negative implications of scaling innovations. That is not to say that there are no positive implications as well. On the contrary. Here, we address the skewedness in ambitions to scale innovations that require a push in the other direction. Furthermore, the case for scaling has been made so many times already that we choose to focus on concerns here.

2.5.1 Resisting scaling bluff

We briefly explore five ways to prevent being bluffed when we are confronted with scaling bluff such as described. The first option is to ask for a detailed explanation of the implications of what is proposed. For example, what exactly is meant to go to scale, on what scale, and to what scale level (Box 2.7). It means insisting on making explicit what exactly is meant to be scaled under the flag of calls for 'scaling food and nutrition security' or 'scaling climate-smart agriculture'.

The second option is to double-check claims. Visser (2010, 2013) challenges the idea that the industrialisation of agriculture in the Netherlands was allegedly impossible to prevent because of the need to produce more food. The idea created the perception (framing) that it was good and saving the population from food insecurity.

Box 2.7: Between myth and bluff

Montgomery (2017) discusses some myths about the need for scale in agriculture. One myth is that large-scale agriculture feeds the world today. It turns out that family farms produce over three-quarters of the world's food (FAO, 2014). Another myth is that large farms would be more efficient. In industry that is often the case (up to a certain level), but agriculture is not industry (see also Duffy, 2009; Visser, 2010). A third myth that Montgomery discusses is that conventional farming is necessary to feed the world and that organic farming is a recipe for global starvation. The most extensive yield comparison to date, a 2015 meta-analysis of 115 studies (Ponisio et al. 2014), found that organic production averaged almost 20 percent less than conventionally grown crops, a finding similar to those of prior studies. But the study went a step further, comparing crop yields on conventional farms to those on organic farms where cover crops were planted and crops were rotated to build soil health. These techniques shrank the yield gap to below 10 percent (Montgomery, 2017).

Visser provides evidence that it was based mainly on a paradigmatic position and not on needs. This relates closely to asking for complete details on the vested interests in particular innovations supposedly needing to go to scale. For example, multinationals need markets for their chemicals and poisons. Will they just wait and see how their markets expand or shrink? What are the scaling ambitions in their business models? And how may this translate into scaling bluff? (Visser, 2013). To be fair, this includes a need to double-check claims made through scaremongering and allegations made by those who oppose innovations and their scaling.

The third option is to work with new ways of measuring progress that look beyond basic economic indicators (e.g. AtKisson, 2012; Costanza et al. 2009). This changes the scales on which the scaling of innovations will be assessed. The fourth option is to expose the implications of scaling ambitions by putting them in a perspective of societal concerns and debates (see Table 2.1). This includes exposing blame-shifting where e.g. the private sector accuses policymakers and government of lack of leadership as a way to escape a need and moral obligation to take responsibility itself (Accenture, 2012). The fifth option is to require a reframing of scaling ambitions using different terms that better explain what they involve and affect. As discussed in section 2.2.3, the framing of impact at scale is quite inappropriate, and the term scaling tends to conceal what change processes and what drivers of change are involved. The problem is not really the term and its widespread use as such, but it can be an indicator of a wrong type of paradigm underpinning change ambitions and initiatives.

2.5.2 Rebalancing pro-scaling bias

Pro-scaling bias is about considering the scaling of 'good' innovations as an a priori good idea. This may be so for various reasons: technical (it works better at scale), strategic (it has more effect at scale), economic (it is more efficient at scale), social (it is needed at scale), ethical (it can be distributed more fairly at scale), and so on. The

problem is that usually only one or a few of those scales will be considered. As a result, we may encounter issues related to the implications of scaling as discussed in section 2.3.3. We give a number of examples in the following.

Decades of investment of economic and development resources have "scaled 80% of global wealth into the hands of less than 10% of the world population" (Davies et al. 2008:2). Barnosky et al. (2012) conclude that we are approaching a state shift in Earth's biosphere due to our scaling of innovations. Gore (2015) discusses the very high correlation between income levels and pollution, reporting that the richest 10 percent of the world's population are responsible for 49 percent of total lifestyle consumption emissions. Banks have created more money than in the entire history of the world prior to 2003 and four times what the 'real' economy has needed for its growth (Stiglitz, 2010, quoted in Goudzwaard & Bartholomew, 2017).

Alternatives have been and are being proposed to change the dominant paradigm of economic growth and the associated ideology of progress. These include ideas regarding green growth, green economy, sustainable development, green GDP, de-growth, decoupling (of economic growth from environmental impact, e.g. see UNEP, 2011), and new ways of measuring progress and development, such as the Gross Happiness Index, Sustainable Society Index, Social Progress Index, or Sustainable Human Wellbeing (AtKisson, 2012). These alternatives are hotly debated, with some considering some alternatives as being too light (e.g. decoupling does not work) and not really addressing root causes (such as green growth and the green economy allegedly being no more than window dressing and not addressing root causes such as consumerism and materialism, which require a cultural change), or that they would be proposing things that are irresponsible (de-growth allegedly destabilises economies too much) (Jackson, 2010)). The World Bank (2012) proposes inclusive green growth as the way towards sustainable development. This would involve three moral imperatives: "satisfying human needs, ensuring social justice, and respecting environmental limits" (World Bank, 2012:?). Who can be against that?! However, the tendency is to keep the basic paradigm of growth and the pro-innovation bias intact, e.g. by proposing innovations towards sustainability (Lehmann-Waffenschmidt, 2007), for which reason Levidow (2011) asks: "*Agricultural innovation: sustaining what agriculture?*" Or through 'responsible' (agricultural) investments (see related principles, FAO, IFAD, Jochemsen, 2012; UNCTAD & the World Bank Group, 2010), which many doubt will contribute to sustainable development (e.g. Castellanelli, 2017; Schoneveld, 2017), also because those who support that initiative represent only a small portion of those investing, and because of its voluntary nature. This allegedly creates oxymorons such as sustainable monoculture (Grain, 2006) and responsible capitalism. Galaz (2014), discussing the implications of the Anthropocene, puts high hopes on institutional and technological innovations, with a focus on the latter. The

idea of decoupling economic growth from resource use and environmental degradation (e.g. Accenture, 2012; UNEP, 2011) is critiqued for being an impossible idea, as it hinges on two incompatible approaches: economic growth and reduction of the associated burden on nature and society (e.g. Jackson, 2009). This is where technologies are again proposed as making the impossible possible.

The above reflections show a general reflex of accelerating along the lines of existing models rather than changing them (Bloomberg News, 2017). Others have argued for reconsidering paradigms underpinning industrial agriculture (e.g. McIntyre et al. 2009; UNCTAD, 2013), including addressing political paradigms that underpin such an outlook on agriculture, which some frame as political agronomy or contested agronomy (Sumberg & Thompson, 2012; Sumberg et al. 2014; Sumberg, 2017). This involves paying attention to political dimensions of agronomic knowledge and technology, to issues of authority and power, and considering political, economic, and social forces and factors such as power relations, contestation, and conflict. Scaling innovations may imply scaling interests of those in power.

The report entitled *Late Lessons from Early Warnings* (Gee et al. 2013) attests to the fact, exemplified in the Dutch expression mentioned in section 2.3.3, that sometimes something bad needs to happen before people will reconsider patterns of behaviour. Blaming population growth rather than extreme and selective consumerism is not the way to go (Pope Francis, 2015). The Global North owes an ecological debt to the Global South, and there is a need to escape the technocratic paradigm, which "accepts every advance in technology with a view to profit, without concern for its potentially negative impact on human beings" (Pope Francis, 2015:§109).

2.5.3 Reconsidering scaling belief

Reconsidering the scaling belief is about challenging fundamental ideas about progress and development. *This concerns reconsidering visions for society and not just reconsidering solutions for society*. When visions remain oriented towards economic growth and progress, 'solutions' will merely shift problems to other areas of life, or to other groups of the world population. The SDGs, with all good intentions and positive aspects, are still within a framework of engineering society to meet certain standards. The question is whether that is the world we want, a world that we want to shape and control through technology (Goudzwaard & Bartholomew, 2017) and through the mechanism of scaling innovations as its trump card. Bergeijk & van der Hoeven (2017) argue that the treatment of inequality in SDGs is wholly insufficient, failing to recognise growing differences between the income of work and the income of capital and the super-rich, which places strain on a country's social fabric.

In light of the critical challenges facing humanity consequent to scaled-up consumption and wastage, many demand a regime change, which is not so much about changing political parties as about changing models for society (Gough, 2017). Smith (2016), for example, argues that "the practical possibilities for 'greening' and 'dematerializing' production are severely limited. This means (…) we're all onboard the TGV of ravenous and ever-growing plunder and pollution (…) and we can't shop our way to sustainability because the problems we face cannot be solved by individual choices in the marketplace"[14]. He therefore contends that there is no choice but to overthrow capitalism and replace it with a democratically planned socialist economy. Others, such as Constanza et al. (2012), call for a total change in economic–ecological orientation. Although this does put ideologies on the agenda as major causes for unsustainable (social, environmental, and economic) behaviour, it runs the risk of turning to a new model that in time will become another absolute, leading to problems in other areas of life.

Dominant narratives underpinning the idea of scaling innovations for development and progress are all about reducing reality to something that creates distorted perspectives, but changing ideological models for new models (e.g. dumping capitalism [Klein, 2015], green capitalism, or rather eco-socialism as Smith [2016] suggests) still does not get to the heart of the matter, which is about paying due respect to all aspects of experienced reality without making any one of them an absolute (Brandon & Lombardi, 2010). This is about much more than the climate and associated causes and effects. It involves asking the right questions, including: what constitutes human wellbeing and how can it be measured (Gough, 2017), what is the fundamental orientation of an economy to be (Goudzwaard & de Lange, 1995), and ultimately, what makes people choose, and behave in, ways that support human flourishing and environmental integrity (Theos, 2010)?

2.6 From critique to counsel

We realise that patterns rooted in paradigms and ideologies and institutionalised in structures and systems do not change easily. In this section, we focus on a modest attempt to change ways of thinking and practice related to scaling innovations. In the previous sections, we have unravelled critical aspects of the scaling innovations for development and progress approach. We have, however, also stated that it is certainly not all bad news and that society has also benefitted significantly and sustainably from scaling innovations. For more than one reason therefore, the scaling of innovations will continue to feature prominently in society. We may frame a contribution to the rethinking of the scaling of innovations for development and progress along three

[14] Quote from book introduction on http://www.truth-out.org/news/item/21060-green-capitalism-the-god-that-failed

lines: first, responding to scaling rhetoric through responsible innovation and scaling (e.g. Wigboldus et al. 2006); second, responding to the scaling paradigm through the governance of sustainable development, which is sensitive to scale and to the implications of scaling innovations (e.g. Padt et al. 2014; Termeer, 2014; Weitz et al. 2017); and third, responding to the scaling ideology through embracing an economy of sufficiency, caring, and sharing (e.g. Goudzwaard & de Lange, 1995).

In this section, we briefly explore related ways forward for sensitising decision-making processes to potential implications and complications of scaling innovations. Responding to ethical, political, social, and ecological concerns requires decompartmentalisation of single-disciplinary, single-sectoral, and single-scale efforts in both study and practice (Fry, 2008) and involves a transdisciplinary approach and practice (e.g. Byrne et al. 2017).

2.6.1 Caring for what really matters at scale

Generally, what drives scaling ambitions is economic growth and prosperity, and people in the driving seats of national and global economies are taking an increasingly disproportionate share of this for themselves (Credit Suisse, 2017; Davies et al. 2008; Gore, 2015). Also, it leaves the environment at the mercy of what a growth economy spares and does not spare. In the midst of this, in development and progress accounts, science, technology, and innovation are front and centre. Issues of social justice and moderation are side issues at best. Ambitions to achieve impact at scale are mostly about material prosperity. An internet search for such terms as 'scaling (social) justice', 'scaling solidarity', or 'scaling good care/stewardship' does not render many options for reading, although such things are at the heart of the fabric of society. These topics never make it to the top of what are considered global risks (World Economic Forum, 2017:Figure 2). Haugen (2015) states that development work that does not address justice is deeply crippled. This provides one piece of counsel: in scaling innovations (from design to evaluation), consider implications for such fundamental issues as justice, solidarity, and good care and stewardship (cf. Jochemsen, 2016). If the scaling of innovations is put at the service of justice, it would not just be aiming at, and result in, mere improved products and services. Food security without justice does not suffice (Ogunrinde et al. 1999; Wills, 2017). Not so much technologies, but justice will create opportunities for achieving food security for the so-called bottom billion (Stumpf et al. 2015).

Rather than turning this into a debate on Capitalism, Socialism, or other ideologies, different points of departure have been proposed – for example, considering relationships and human flourishing (Theos, 2010) as the foundation of any society, translating this into policies for government, finance, international relations, and

more (Schluter & Ashcroft, 2005). Along similar lines, Strasser et al. (2012:20) speak about the "humanisation of the world of work". Relationships and human flourishing are fundamentally about care (Goudzwaard & de Lange, 1995) and justice (Haugen & Boutros, 2015). This includes developing a new language of impact at scale, such as the poetic "let justice flow like a river and righteousness as a never-ending stream"[15] as an alternative to scaling rhetoric. This relates to the approach of 'change what needs to be changed, not what is easy to change'. Along these lines, Pope Francis (2015) calls for lifestyle change, away from consumerism and collective selfishness, and the need for ecological education everywhere in society. Goudzwaard (2012:65) goes even a step further, suggesting that "If the west would truly take the problem of increasing poverty in the South seriously, then it would accept that at least a substantial part of the benefits of creating international money should go directly to the poor countries, which would then enable them to pay off their debts".

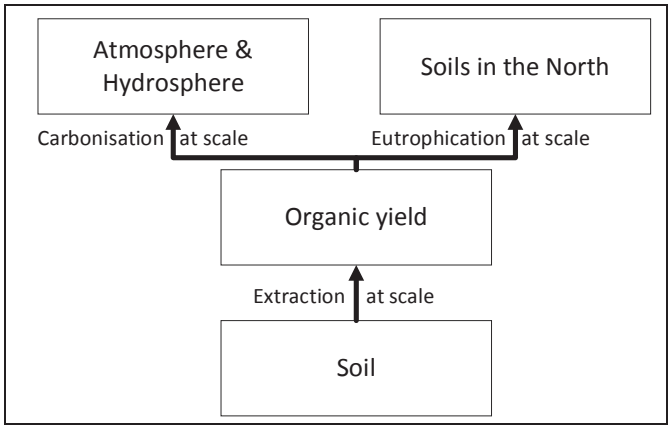
But justice is also about doing justice to a key source upon which all food security is based: the soil. We explore this a little more deeply here as an example of things that matter most, realising that we cannot do justice to this important topic. If we care about the soil, we support food security. Much attention is paid to climate change, which is attributed largely to effects of carbon emissions, which are the effect of large-scale use of fossil energy (distorting balances as carbon emissions exceed carbon sequestration) and agriculture. However, much less attention is paid to the large-scale distortion of balances in the soil, particularly in the rhizosphere. Some consider this to be a ticking time bomb that is seriously jeopardising soil fertility (Visser, 2010; Montgomery, 2012). As it is not experienced as much as climate change, science has not taken this sufficiently as a priority area for research, focusing more on biomolecular studies and breeding programmes that are partly the very (indirect) cause of the destruction of healthy soils (Visser, 2013). As discussed earlier, technologisation is a process that removes people from the soil as part of their identity and basis for existence. Figure 2.8 focuses on the more material side of the centrality of soil in society. For sustainable decarbonisation, soil rehabilitation must be made a priority in climate-smart agriculture and development efforts in general (e.g. Fay et al. 2015; Mwongera et al. 2017). The continuing possibility to purchase carbon credits

is an abuse of soil, is a perverse incentive, and sustains asymmetric scaling, thus sustaining what at heart is unsustainable agriculture (Visser, 2013). This involves adopting and enforcing the application of new principles for agricultural development such as exemplified in cases of 'Green Gold' shared by John D. Liu[16] and in the N2Africa research in development programme (Giller et al. 2013). It is about changing the

[15] Passage from the Bible, Amos 5:24.
[16] E.g. see https://permaculturenews.org/2012/11/17/finding-sustainability-in-ecosystem-restoration/

orientation from valuing products of the source (soil) more than the source, to an attitude of valuing the source as of primary importance. This involves adjusting agriculture (and associated extraction of produce) to the specific carrying and regeneration capacity of the soil.

Figure 2.8: Illustrating the centrality of the soil in society



2.6.2 Constructing an ethics of scaling innovations

All kinds of ethical approaches have been developed for many fields, but there is not yet something like an 'ethics of scaling'. Such ethics will need to be connected to an ethics of technology, innovation, and responsibility (e.g. Mulgan, 2016; Schuurman, 2005, 2010; Verkerk et al. 2016). However, as stated earlier, it concerns a distinct dynamic that is often not specifically, and therefore not sufficiently, addressed in those ethics. An ethics of scaling innovations needs to be an evidence-supported ethics that is capable of challenging scaling bluff, scaling bias, and scaling belief to escape the self-replicating interaction between innovations and ideologies (e.g. Figure 2.7). Scaling innovations is a way of sustaining such self-replication. Such ethics needs to be part of design processes (ex ante) because "(…) the ethical debate about scientific discoveries has become largely a debate after application, a postdebate" (Goudzwaard et al. 2007:89). It involves making economic considerations subordinate to social and moral considerations (McIntyre, 2009) and to ecological considerations (Visser, 2013). This includes topic-related ethics such as an 'ethics of soil', involving the effects of scaling innovations on soil and soil life (Thompson, 2011), food justice (Hayes & Carbone, 2015), and food ethics[17]. In other words, it requires the use of several different critical approaches, depending on the case and not grounding it in just one or two perspectives or traditions of critique (Feenberg, 1996).

In practical terms, such ethics needs to be able to link futures across scales (Lovell et al. 2002) to create a dialogue on multi-scale scenarios (Biggs et al. 2007), while acknowledging that not everything can be anticipated and foreseen (Giddens, 1999). Furthermore, there is a need to connect to multiple models rather than just one. Taking the case of efforts in relation to biofortification – the enrichment of staple food

[17] E.g. see *Food Ethics*, a journal devoted to agricultural and food ethics http://www.springer.com/philosophy/ethics+and+moral+philosophy/journal/41055

crops with essential micronutrients – we note that these efforts exemplify a model of global, 'public goods' science that is emerging within complex, international research networks and that runs the risk of a search for 'silver bullet' solutions at the expense of more incremental approaches that respond to locality, diversity, and the complex and uncertain interactions between people and their environments (Brooks, 2010; see also Kidd & Richter, 2006). This becomes even more important in light of increasing concerns over food security that are leading donors and policymakers to commit to ambitious visions of impact at scale (primarily focusing on intensification of current models, not on revision or diversification) – visions which may never become a reality and may limit the scope of alternative pathways which are pursued (Brooks, 2010).

This also relates to the question of hidden agendas and how much transparency can be expected in this kind of discourse from those who have vested interests that are not necessarily for the common good (Keijzer & Lundsgaarde, in press). It further involves a change of focus from progress to achieving harmony in which all aspects of experienced reality are simultaneously and comprehensively addressed. The theory of modal aspects (e.g. see Brandon & Lombardi, 2010) provides a useful framework for this to identify where (a tendency towards) reductionism lurks (Basden, 2017). In the next section, we provide further explanation when discussing contributions to cultivating responsible scaling. The theory of modal aspects framework offers not so much a guide to progress as a normative framework to assess any claims about making progress. It also offers a way of providing a matching ethical framework to the SDGs. The fact that such goals have been agreed and that many efforts are linked to them may give a misleading sense of security that 'as long as good goals are set, we are fine'. Increasingly, questions are being asked about whether the road travelled will get us there (Winkler & Williams, 2017).

2.6.3 Cultivating responsible innovation and scaling

The idea of responsible innovation (Stilgoe et al. 2013) provides a stepping stone for developing a perspective on responsible scaling, or, rather, on responsible innovation and scaling. Responsible scaling is about applying necessary and appropriate checks and balances on ambitions to scale innovations (Box 2.8 outlines keys to responsible innovation and scaling). "To decide what responsible innovation means, it is necessary to understand the ethical significance of innovation as a kind of action that can significantly alter the natural and social worlds and the human condition. It is often assumed that such changes are introduced responsibly only if we act with foresight, by striving to predict the consequences of what we do. This characteristically modern consequentialist position is, nonetheless, inappropriate. Part of the technological condition is how the future is being constituted through innovation, meaning that past predictions will often be wrong, and sometimes spectacularly so" (Grinbaum &

Groves, 2013:1; see also Blok & Lemmens, 2015). Guston (2015) rightly pointed to the fact that few people will be against responsible innovation anyhow. The same goes for responsible innovation and scaling. It is therefore critical to translate this broad idea into operational perspectives and guidance to avoid working with a 'no-brainer' concept.

Box 2.8: Keys to responsible innovation and scaling

Overall:
- Harmony orientation: doing justice to all relevant aspects simultaneously (Chapter 3 discusses this in more detail)

Specifically:
- Proportionality: all in good measure
- Contextualisation: all in good place
- Distribution: all in fairness and justness
- Anticipation: all in good time, place, and measure

We briefly mention some further contributions that can feed into the development of an ethics of scaling innovations and inform frameworks for responsible scaling, starting with the theory of modal aspects to which we already referred in the previous section.

Brandon and Lombardi (2010), following Dooyeweerd's theory of modal aspects (for an accessible explanation, see Basden, 2015), developed a framework to assess sustainability in the built environment. This provides a comprehensive and integrated perspective on aspects of experienced reality. Each aspect involves a law of what makes for treating the aspect with due justice. If we go against it, it will have negative repercussions for entities to which it pertains. We cannot go against the law of one aspect and compensate it in another aspect. For example, we cannot deny justice (juridical aspect) to a group of people and then just be more friendly (social aspect) and/or provide monetary compensation (economic aspect). Harmony flows from the simultaneous realisation of normativity related to each aspect. This occurs within a perspective of achieving harmony and flourishing, where the term 'progress' does not fit. It is about interactive harmony between aspects[18]. Dysfunctionality in any aspect can jeopardise the whole functioning of entities, especially when one aspect is made an absolute (involving reductionism) at the expense of doing justice to other aspects (Box 2.9). Such approach would ultimately be self-defeating. We explore this perspective further in Chapter 3.

Box 2.9: Illustration of the application of the theory of modal aspects (adapted from www.dooy.salford.ac.uk/progress.html)

The problems of Western progress can be seen in aspectual terms, for example:
- Biotic: the threat to life functions, especially ecology
- Sensitive: the increasing stress in society and between cultures
- Lingual: information overload and 'digital gap'
- Social: the breakdown in, and commodification of, relationships

[18] See also http://www.dooy.salford.ac.uk/shalom.html

- Economic: greed, waste, and the squandering of resources
- Aesthetic: fragmentation and de-harmonisation of life, and reduction of playfulness
- Juridical: trampling on rights of the marginalised, and of other species
- Ethical: increased competitiveness and self-centredness
- Certitudinal: the tunnel visions of economism, technicism, scientism

Stein & Harper (2013:150), discussing a designer's ethical responsibility, challenge what they frame as rationality being limited to "instrumental rationality: finding the best means to a given end". They argue that "the dominance of an instrumental view of people and environments has often resulted in their being treated as objects. As technology has made a wider range of goods available to increasing numbers of consumers, and as they become further separated from the design and production of consumer goods, people have lost their feeling of connection to their material environments. This separation has lessened feelings of meaningful relationship to their artifacts and their environments, making them feel objectivized as manipulated

consumers, that is, less fully human. With minimal awareness of it, designers and planners have played a significant role in this process of dehumanization" (:163). They argue that there is an ethical responsibility to resist such process and "to reassert the value of persons, by designing and planning in ways that increase the meaning of artifacts and environments to users" (:163). They discuss possibilities of doing this at different scales of design (Stein & Harper, 2013; see also Myerson, 2016).

The techno-ethical scenarios approach proposed by Boenink et al. (2010) aims at ethical assessments of emerging technologies that are intended to help policymakers to anticipate ethical controversies regarding emerging technologies (see also the ethical matrix as proposed by Mepham et al. 2006). The approach proposed by Boenink et al. relies on scenario analysis, which involves the construction of possible future scenarios for the development, application, and impacts of new technology. A unique feature of the approach is that it aims to anticipate the mutual interaction between technology and morality, and changes in morality that may result from this interaction. Boenink et al. argue that technology may change the way we interpret moral values and may also affect the relative importance of particular moral principles. For example, privacy may become a less important principle in an information society where personal information is ubiquitous, and the concept of human responsibility may change in a society in which human decision making is supported by expert systems. Boenink et al. want such changes to be taken into account when new technologies are being ethically assessed, so that new technologies are not evaluated from within a moral system that may not have the same validity by the time an emerging technology has become entrenched in society. Related contributions include future-oriented technology analysis such as forecasting innovation pathways

for new and emerging science and technologies (Robinson et al. 2013), which includes considering related processes such as commercialisation. Relevant trade-off analysis (e.g. Klapwijk et al. 2014) requires a good understanding of scaling processes and how different ongoing scaling processes interact with one another. That is what modelling and simulations are aiming for, but they will always be limited; and their results may also be quite misleading, as discussed in section 2.3.2.

Manufactured risk is about "hazards and insecurities induced and introduced by modernisation" (Beck 1992:21). Giddens (1999:9) assumes that the balance of benefits and dangers from scientific and technological advances, and other forms of social change, is "imponderable". He therefore argues that the precautionary principle would be too strict in requiring evidence of no risk involved. This situation is further complicated by the dilemma of scaremongering versus cover-ups: some will bluff about risks that are highly unlikely, whereas others will try to bluff away real risks by cover-up stories or by manufacturing doubt (e.g. Oreskes & Conway, 2011). In light of this, Pope Francis (2015:§186) proposes differentiated responsibility for actors given their capacity, and also given their causing of problems, and suggests working with a moderate form of the precautionary principle: "if objective information suggests that serious and irreversible damage may result, a project should be halted or modified, even in the absence of indisputable proof". Alternatively, Giddens (1999:9) expects more from variations on the precautionary principle, such as the need to present evidence of having thought through the entire production and disposal cycle. The bottom line is that situations of manufactured risk relate differently than external risk to the issue of responsibility. It relates more to collective responsibility (for a societal course of action), to responsibility to future generations (in light of what is being done to nature) and may lead to a situation of organised irresponsibility (Beck, 1992). It requires a better understanding of the multifaceted dimensions and dynamics of risk and responsibility (van der Poel & Fahlquist, 2012, have written an excellent outline of related concepts), particularly in light of the assessment that "the increase in our knowledge about our role in the environment cannot keep pace with the increase of the unknown impact of our actions" (Westley et al. 2011:764). The increasing awareness of the complexity of biological, ecological, and technological systems therefore requires making methods, models, and assumptions used in risk assessment broader and more inclusive, transparent, and accountable (Stirling, 2010).

The work on considering planetary boundaries and a safe operating space are gaining momentum and are all about scaling processes (Häyhä et al. 2016; Rockström et al. 2009; Steffen et al. 2015). This is also about sharing, and who and what gets what share on this planet. This is where things become sensitive for those who have bigger-than-responsible footprints. There is a need for a whole set of footprints, such as the carbon

footprint, the chemical footprint, the biodiversity footprint, the land-use footprint, and the blue and green water footprint. In related ways, there is a need to develop new perspectives on scaling innovations. Scaling innovations often follows patterns (of disruption) such as discussed in section 2.3.3: selective scaling, asymmetric scaling, and excessive scaling. Box 2.10 explores alternative patterns.

Box 2.10: Making the purpose orientation of scaling ambitions explicit

Rather than just speaking in terms of scaling out, horizontal scaling, vertical scaling, or scaling up, it helps to be more specific about what the scaling initiative essentially seeks to do. Suggested type of categories:

- Restorative or regenerative scaling: scaling to restore disturbed balance/harmony (e.g. landscape restoration and rehabilitation[19])
- Responsive scaling: Scaling to respond to already ongoing scaling processes (e.g. climate change, rising river tables[20])
- Corrective scaling: scaling up or down to enhance harmony (e.g. because previously scaled innovations were found to be harmful or because of vulnerability caused by e.g. monoculture: need for diversification)
- Opportunistic scaling: an innovation is found to hold potential for wider use/application; the focus is mainly on capitalising on such potential

Other topics to address in cultivating responsible (innovation and) scaling include considering the cost of normative behaviour: 'if I don't do it, someone else will'; the Lisbon principles of sustainable governance, which are about responsibility, scale matching (at different levels of governance), precaution, adaptive management, full cost allocation, and participation (Gripenberg et al. 2012); sustainability as direction in considering what makes for ethical decision making (Kilber et al. 2011), including sustainability education (Corcoran et al. 2017) and the role of civil society (e.g. Wals & Peters, 2017); and learning from nature such as promoted by Raworth (2017) who does not believe that there can be everlasting (economic) growth. In nature, we see (scaling) laws that limit excessive scaling (West, 2017). Why not make and enforce laws that restrain escalating extraction processes? From limits to growth to limits to scaling. Last but not least, Padt et al. (2014) present a key contribution to the governance of scale and scaling. It focuses on environmental governance but offers opportunities for broadening the scope, as discussed in their concluding chapter (see also Newig & Moss, 2017, for a more recent elaboration of concepts).

Approaches such as results-based management may create perverse incentives for developing tunnel visions for impact at scale through a focus (not in line with the principles of the approach as such) on results reporting (Eyben, 2015; Eyben et al. 2015; Holzapfel, 2014). Already in the 1980s, Dichter (1989) suggested focusing more on an

[19] E.g. see http://www.springcollege.org/teachers/john-d-liu/
[20] E.g. see the Dutch Room for the River programme https://www.ruimtevoorderivier.nl/english/

organisation's overall approach to development, considering whether it is strategic, focused, and systematic, and then trust that wider impact will result. He did not think replication needed to be built into projects for that reason.

We conclude that there is a need for analytical and normative frameworks to make choices and consider trade-offs transparently, to consider primary practices and processes rather than focusing on large-scale patterns only (Jochemsen, 2012; Nia et al. 2017), and to create integrated perspectives that prevent reductionisms, such as the sustainable development index (van de Kerk & Manuel, 2008). We explore that in more detail in Chapter 3.

2.7 Conclusion

In this chapter, we undertook a critical assessment of the idea of scaling innovations for development and progress. The use of the term 'scaling' in this context is not incidental and is meant to convey a sense of significance. Although scaling is generally approached as the way par excellence to match the scale of (grand) challenges and the scale at which they are addressed, we found a rather large number of related concerns both in the idea itself and in related practice. We demonstrated how deeply scaling processes were and are part of societal change processes and raised questions regarding the appropriateness of attempts to achieve impact at scale, given that some of the grand challenges facing humanity are the very result of impact at scale that is now deplored. We also demonstrated how the scaling innovations approach is part of wider ideas on progress and development that are the subject of hot debate, such as the economic growth paradigm. We are still puzzled as to why the idea and practice of scaling innovations for progress and development tends to escape serious scrutiny and why it does not receive much specific attention in debates on technology, innovation, and growth thinking. Scaling innovations is often approached as essentially being a business model following marketing principles. Innovations are being 'sold' to a wider public, sold in terms of ideology ('trust this'), in terms of paradigm ('this is good'), and in terms of rhetoric ('this solves problems'). In the rhetoric of scaling innovations, the principle of full cost accounting, which includes social, economic, and environmental implications (Barg & Swanson, 2004; Jasinski et al. 2015), is rarely applied, and as a result there is a tendency to focus exclusively on envisaged benefits.

It is therefore time to start thinking more critically about related processes and ambitions and to translate this into decision making and policy. Not trying to be complete, we proposed three directions in which this may be done: improving our understanding of what scaling innovations implies and involves, developing matching normative perspectives to inform and guide scaling ambitions and related change

initiatives, and broadening the idea and concept of responsible innovation towards a perspective on responsible innovation *and scaling*. We have only scratched the surface of such new directions for the governance of scaling innovations. The following chapters explore some of this in more detail.

Thinking critically about scaling innovations for development and progress is not about discarding the idea as such as if there should be no place for scaling innovations and as if it only yields sour fruits. Rather, it is about discovering what makes for good balance, good proportions, and harmony: all in good measure, in good place, and in good time. Grant donors need to reconsider their role in pushing for the scaling of innovations without allowing proper checks and balances (involving appropriate investments to make this possible). The research for development (R4D) approach needs to consider the extent to which the espoused scaling dimension is looking beyond merely being put at the service of economies of growth and progress and at least to be aware of the ideological roots associated with ambitions to scale innovations emerging from research practice.

This is an abbreviated account of a wider-ranging study. We have not discussed other relevant angles such as the role of inter- and transdisciplinary work. We have demonstrated the need for a rethinking of the scaling of innovations for development and progress and pointed out some aspects of what this may encompass. This, however, is a first step only and needs to be further explored and developed, including in terms of finding the appropriate balance between considering the sweet and the sour fruits of scaling innovations and considering when it is an issue of a yes-or-no choice and when it is an issue of a trade-off. Trade-off analyses will need to be informed by sufficiently comprehensive perspectives on negative implications of disruptive scaling as discussed earlier in this chapter. Chapter 3 discusses such perspectives further.

CHAPTER 3

Systemic perspectives on scaling agricultural innovations. A review

3

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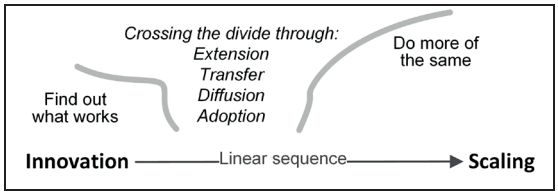
3.1 Introduction

Increasingly, development agencies, governments and donors assess the impact of agricultural research and innovation by the extent to which outputs and outcomes in the form of novel technologies and practices can lead to wider benefits (Joly et al. 2015). This is often referred to as a process of 'scaling' to achieve 'impact at scale' (e.g. Anderson, 2012; Clark et al. 2012; Little, 2012; Millar & Connell, 2010). Scaling processes are conceptualised in various ways, with a distinction often being made between scaling up and scaling out (e.g. Anderson, 2012; Menter et al. 2004; Millar & Connell, 2010). Scaling up means something similar to increasing (e.g. in terms of numbers, speed, size), whereas scaling out often relates to expanding, such as geographically spreading the use of a particular technology. In this paper, we use the overall term, scaling. A prominent assumption underpinning most scaling initiatives is that, if products, processes or practices go to scale, (positive) impact will scale with it, hence the common approach of 'find out what works (in one place) and do more of the same (elsewhere)' (Figure 3.1). In this approach, transfer and dissemination leading to diffusion and adoption are frequently used concepts (German et al. 2006; Kuehne et al. 2013; Maredia, 2014; Reimer et al. 2012; Schewe & Stuart, 2015). There are two important problems with this approach in relation to understanding the complexity of scaling.

Figure 3.1: Scaling (up) as a linear process



Firstly, it is increasingly recognised that transfer and dissemination, and related to that diffusion and adoption, of technologies and practices are not linear processes; rather, substantial reworking of technologies and practices happens in scaling processes (Douthwaite et al. 2001; Millar & Connell, 2010; Garb & Friedlander, 2014). However, approaches to scaling using concepts such as adoption, transfer and dissemination (e.g. Abebawa & Haile, 2013; Dibba et al. 2012; Peshin, 2013; Rogers, 2003; Wejnert, 2002) tend to focus mainly on attributes of technologies and adopters that determine adoption likelihood. They do not always prepare prospective users sufficiently to engage with the systemic and complex dynamics involved in, and resulting from, scaling processes. Adoption thinking does consider the importance of social networks as an influencing factor in farmers' behaviour in relation to, for example, the adoption of more sustainable practices (Pannell et al. 2006) and increasingly looks at how configurations of social networks influence adoption behaviour (Aguilar-Gallegos et al. 2015; Hoang et al. 2006; Spielman et al. 2011; Thuo et al. 2014). However, adoption thinking tends to remain focused on informing interventions (e.g. policies) aimed at farm level and is less explicit about interventions

that create a conducive environment for change overall (e.g. by changing value chains and markets, consumption patterns, citizen values). Furthermore, adoption approaches and studies tend to focus on transfer and dissemination success, such as the number of farmers using a particular technology, and much less on long-term, cross-domain and cross-scale consequences of dissemination and diffusion.

Secondly, work on scaling, using concepts such as transfer and dissemination, and diffusion and adoption, focuses on what works in a particular ecological, geographical or socio-cultural area, but technologies and practices do not necessarily work, and may even have negative effects, in other areas (Coe et al. 2014; Garb & Friedlander, 2014; Gee et al. 2013; Menter et al. 2004).

Technologies and practices that are perceived as sustainable and inclusive may even work out quite differently when applied at large scale or under different ecological, geographical or political conditions (e.g. Menter et al. 2004; Rotmans & Rothman, 2003; Schulze, 2000; Wu et al. 2006). For example, rubber cultivation was seen as a way out of poverty in Southwest China, but, when it eventually covered one-third of the landscape, environmental degradation became dramatic (Xu et al. 2014; Ziegler et al. 2009) (Figure 3.2). Hence, what is promoted as a solution and scaled at one point in time may later be considered an environmental hazard (EASAC, 2015; Gee et al. 2013). When something has gone to scale, it may be difficult to scale it down again, even if it produces negative side effects (Scheffer et al. 2009; Scheffer 2010; Ziegler et al. 2009; van den Berg et al. 2012). Many of these concerns inspired the development of ideas regarding 'responsible innovation' (McNaghten et al. 2014; Stilgoe et al. 2013; Stirling, 2015; van den Hoven et al. 2014), in which possible negative effects are anticipated; this eventuality applies also to scaling (hence this is seen as 'responsible innovation and scaling'—see Table 3.1). These ideas are becoming increasingly important given the debates on 'contested agronomy' that emphasise the politics of technology development and scaling (Sumberg et al. 2013). Some authors have suggested that our capacity for technological innovation is increasingly exceeding our capacity to foresee the long-term impact of technologies and practices

Figure 3.2: Scaling rubber cultivation in SW-China brought financial affluence to many communities, but also eroded biophysical and cultural diversity at scale

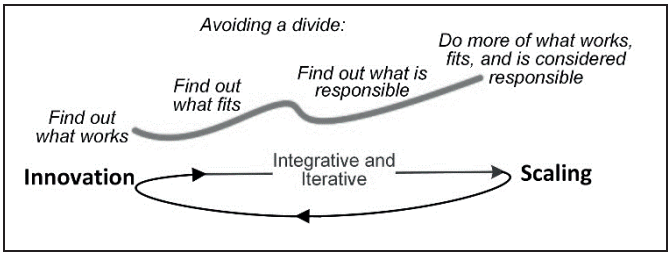
(Gee et al. 2013; Koohafkan et al. 2012). We would argue that scaling dynamics are at the heart of such concerns, as they create a multiplier effect on potential negative outcomes. This effect may, for example, relate to increased vulnerability due to dependency on monocultures, as happened as early as the nineteenth century in the case of potatoes in Ireland (Woodham-Smith, 1962). It may also relate to depletion or contamination of resources, which happened, for example, in Bangladesh due to scaling of ground water extraction (Hossain, 2006).

Table 3.1: Dimensions of responsible scaling (adapted from Stilgoe et al. 2013)

Anticipatory: Anticipating 'what if this goes to scale?' as well as anticipating what emerging futures the scaling process may need to connect to (e.g. in terms of trends)
Responsive: Responding to both societal needs and societal concerns expressed by all stakeholders; this involves considering all aspects as discussed in this paper
Reflexive: Reflexive and adaptive management informed by ongoing evaluation of the functionality of scaling up in view of a defined purpose, rather than mere rolling out of blue-print 'solutions'
Inclusive: Inclusive in scope (what is in the picture): inclusive in process (collaborative): inclusive in effort (convergence), and inclusive in terms of who benefits

The above reflections illustrate how many scaling processes involve complex dynamics that should be addressed not only in the dissemination or adoption stage, but also in the design and development of technologies and practices to inform 'best bets' and 'best fits'. Concerns about this issue have led some to advocate for participatory design and best-fit options, requiring processes of adaptation and translation (Cerf et al. 2012; Garb & Friedlander, 2014; Giller et al. 2011; Klerkx et al. 2010; Knowler and Bradshaw 2007; Shiferaw et al. 2009; van der Stoep & Strijbos, 2011). This implies that, rather than being considered as the logical follow up of novel technologies and practices that resulted from successful research and innovation, scaling should be considered as part of a more continuous process involving ongoing fine-tuning (Figure 3.3). In this perspective, research and innovation need to anticipate such adaptive (scaling) processes and therefore design with future (potential) scaling up in mind (Expandnet, 2011; Ghiron et al. 2014; Middleton et al. 2005). This involves making scaling processes a more integral part of systemic approaches to innovation (Blesh & Wolf, 2014; Foran et al. 2014; Hinrichs, 2014; Klerkx et al. 2010).

Figure 3.3: Scaling (up) as an integrative and iterative process



To be able to address scaling processes from a richer and systemic perspective, we need integrative approaches to design and guide scaling initiatives as well as analytical frameworks to support this. Based on a review of

literature on scaling and system innovation, this paper proposes a systemic framework to address the multiple dimensions and dynamics which should be taken into consideration during scaling processes. To this end, the paper addresses three main questions: What existing systemic perspectives, approaches and frameworks provide a good basis for developing an analytical framework for understanding the dimensions and dynamics involved in scaling processes (Section 2)? How can the identified approaches translate into an integrative analytical framework that activates a systemic perspective on innovation and scaling (Section 2)? How could such a framework be used to assess and inform scaling initiatives (Sections 3 and 4)?

By addressing these questions, we seek to contribute to improved analysis, decision making and policymaking in relation to scaling initiatives by providing richer perspectives than those commonly informing scaling initiatives today. Insights are meant to be first of all be of use to researchers, policymakers, and certainly to those responsible for designing and managing projects which include a clear scaling ambition. This initial approach provides an example of how perspectives on scaling processes may be enriched while requiring further research and refinement on the basis of empirical studies.

In Section 4, we briefly explore ways in which the analytical approach as outlined in Sections 2 and 3 can be used. In the conclusions (Section 5), we briefly reflect on the approach, what it contributes, its limitations and on options for further research and development.

3.2 Towards a framework for systemic analysis of scaling processes

3.2.1 Building on the multi-level perspective on socio-technical transitions

In search of approaches that already include specific analytical frameworks in relation to scaling processes, we selectively reviewed the literature to explore a range of integrated approaches in view of our purpose to build and integrative framework. Thus, review was not exhaustive, which could be seen as a limitation, but as the aim of our paper is to build an integrative systemic framework to analyse scaling, we had to balance width and depth of the review. The purpose of the review was hence not to analyse and compare all approaches in detail but to enable making an informed selection of the approaches useful for our framework. The approaches reviewed include agricultural systems approaches (e.g. Darnhofer et al. 2010; Garb & Friedlander, 2014; van Ittersum et al. 2008; Klerkx et al. 2012; Miller & Newell, 2013; Schut et al. 2014a, b), interdisciplinary (e.g. Frodeman et al. 2010; Wagner et al. 2011) and transdisciplinary (e.g. Brandt 2013; Klein, 2014; Pohl & Hirsch Hadorn, 2007) research approaches, innovation systems approaches (e.g. Lamprinopoulou et al. 2014;

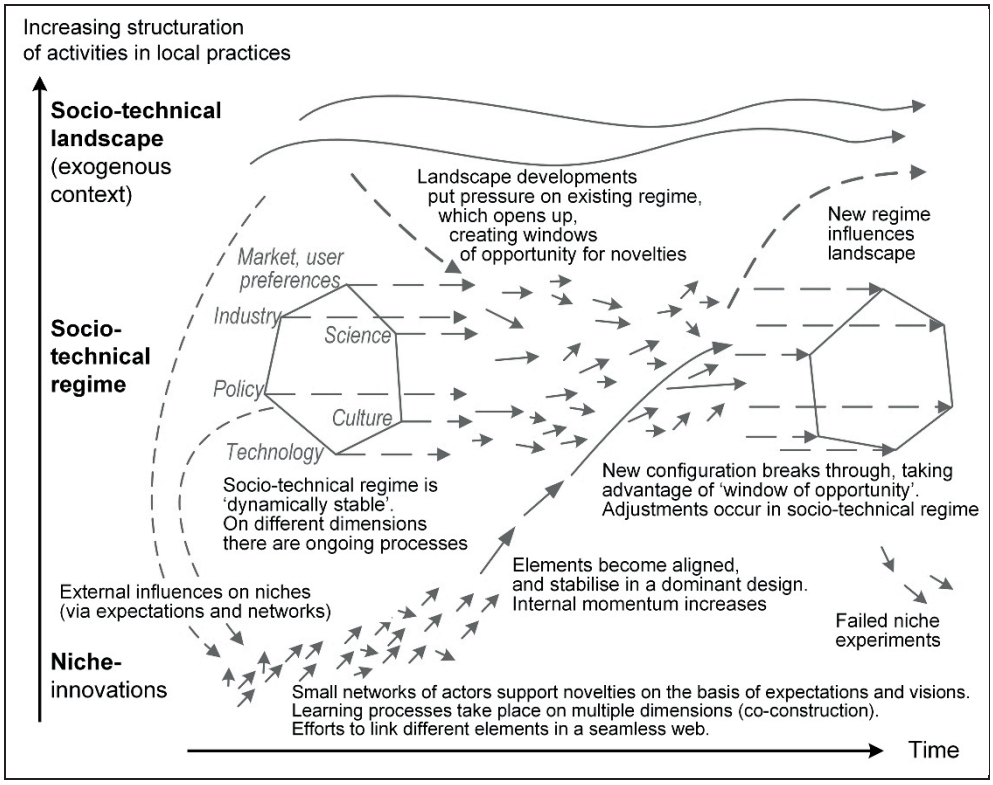
Schut et al. 2014a, b, 2015a, b; Spielman et al. 2009), value chain approaches (e.g. Ashby et al. 2012; Nang'ole et al. 2011), landscape approaches (e.g. Freeman et al. 2015; Kozar et al. 2014; Sayer et al. 2014; Wu, 2013) and socio-ecological systems approaches (Foran et al. 2014; Sinclair et al. 2014; Westley et al. 2013). Although issues of scale do feature in them, such approaches offer no analytical frameworks for developing systemic and integrative perspectives on scaling processes. The call for 'integrative' approaches to research and innovation (e.g. Fischer et al. 2012; van Kerkhoff, 2014; Veldkamp et al. 2009; Weichselgartner and Kasperson 2010) thus rarely includes a plea for integrative and systemic approaches that also pertain to scaling processes. This may be one reason why our understanding about scaling processes tends to remain fragmented regarding what is involved in the success or failure of scaling initiatives (Volk & Ewert, 2011; Willemen et al. 2013).

Approaches relating to the study of transitions to sustainability (Elzen et al. 2012; Geels, 2002; Hinrichs, 2014; Horlings & Marsden, 2011; Kemp et al. 1998; Kemp & Rotmans, 2009; Rotmans, 2003), however, already include perspectives on scaling. They help develop more of a 'bigger-picture' perspective, required for a more comprehensive approach. They are, however, less explicit regarding the specific dimensions and dynamics involved in transitions and associated scaling processes. We therefore chose to build, but also to elaborate further, on the related multi-level perspective (MLP) on socio-technical transitions (Geels 2002). We first briefly introduce MLP and then discuss our suggestions about addressing some of its limitations.

MLP was designed to better illustrate and interpret how radical innovations connect to socio-technical transition processes (Geels, 2002). It is a perspective that is increasingly applied in the context of agriculture (e.g. Blesh & Wolf, 2014; Diaz et al. 2013; Elzen et al. 2011, 2012; Hinrichs, 2014; Ingram, 2015; Lamine, 2011; Morrissey et al. 2014; Sutherland et al. 2015). If this perspective is applied to scaling, it provides insight regarding the dynamics that influence why some innovations go to scale and others do not. The multi-level perspective incorporates three main levels: niche, regime and landscape (Figure 3.4). Although some authors (e.g. Diaz et al. 2013; Geels, 2014; Papachristos et al. 2013) have recently suggested adaptations of the original model, it still revolves around these levels, and the studies mentioned above in relation to agriculture use it in this way.

The regime level relates to the constellation or system of interacting practices and structures that have come to a certain relative stability and status quo. This may, for example, be the status quo in a sector. This stability may, however, be disturbed (perturbed), e.g. as a result of new policies or of changing environmental conditions. This may create opportunities for novelties (innovations) to become incorporated in,

Figure 3.4: The multi-level perspective, based on Geels (2002, 2011)



and change, a regime, particularly those that address or even create such disturbance (perturbation). Novelties (innovations) can benefit from sheltered conditions that favour their emergence (and scaling), for example through dedicated project funding. This is called the niche (level) in which novelties develop. Figure 3.4 suggests that niches come from outside the regime, but sometimes novelties—and, related to that, niches—also develop within regimes (Geels, 2011). The landscape within which this happens may be understood as the wider context, and it is considered to be the least dynamic level relating to, e.g. worldviews, paradigms, culture and politics, which tend to change slowly.

At regime level, MLP describes incumbent systems that involve dominant configurations relating to, e.g. science, infrastructure, markets and technology, and that have established 'institutional logics' (Fünfschilling & Truffer, 2014). These logics are defined as 'the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality' (Thornton & Ocasio 1999: 804). It also points to a range of dynamics involved in related transitions (hence the many arrows in Figure 3.4). Regimes are

usually not deliberately shaped, but rather the outcome of path dependencies leading to a state of being locked into a status quo (e.g. a dominant way of agricultural production) as a result of interdependencies which developed between actors and processes (Holtz et al. 2008; Fünfschilling & Truffer, 2014). Such lock-in often involves power relations where some groups (e.g. proponents of a particular model of agricultural production) may have a vested interest in maintaining such status quo while it conflicts with the interests and aspirations of other groups (Avelino & Rotmans, 2009; Olsson et al. 2014; Avelino & Wittmayer, 2015). Path dependence includes notions regarding causal relationships in which seemingly small events can set in motion much wider historical paths through often non-linear and difficult-to-trace processes (Castro et al. 2014; Ruttan, 1996). The economic concept of path dependence explains how the set of decisions faced for any given circumstance is limited by decisions made in the past, even though the past circumstances may no longer exist (Liebowitz & Margolis, 1995).

Scaling novel agricultural technologies and practices often involves changes in multiple regime elements (e.g. in production systems, but also markets and consumption systems) and may relate to multiple regimes. For example, care farming intersects the farming regime and the care regime (Hassink et al. 2013), and the farming regime overlaps with the energy regime in the case of biofuels (Sutherland et al. 2015). Novel technologies and practices may sometimes drastically change a regime (radical innovations, e.g. a shift from tillage to zero tillage, a shift from intuitive farmer decision making to big-data-driven decision making in precision farming), but sometimes they may affect only parts of the regime when innovation are (in parts) incremental, e.g. using biofuel in tractors (Geels & Schot, 2007). Some criticisms have been voiced about the MLP, the first one being that it is too 'coarse' a framework, in which insufficient attention is paid to unravelling the role of everyday practices and people's agency in niches and regimes (Geels, 2011; Genus & Coles, 2008; Shove & Walker, 2007, 2010). Furthermore, given the focus on socio-technical transitions, biophysical and socio-ecological elements are less highlighted in the regime concept, as well as notions of geographical scales (Coenen et al. 2012; Hansen & Coenen, 2015) whereas they are highly important in the context of agriculture (Dalgaard et al. 2003; Diaz et al. 2013; Foran et al. 2014; Sinclair et al. 2014). Lastly, notions of responsible innovation have so far been less explicitly considered in MLP, although they are mentioned as important and a promising avenue for the further development of MLP (Pesch 2014).

3.2.2 Complementing the multi-level perspective with the theory of aspects

To overcome some of MLP's limitations, we suggest to complement, or rather refine it, to better define the different regime and landscape elements (see also Fünfschilling

& Truffer, 2014; Holtz et al. 2008), how they are perceived by people, and how analysis and decisions regarding sustainability and responsible scaling can be informed. The theory of modal aspects, developed by the Dutch philosopher Herman Dooyeweerd, provides a suite of aspects of experienced reality (Basden, 2008; Brandon &Lombardi, 2011; Jahanyan & Fard, 2012; Ribeiro et al. 2012; Strijbos & Basden, 2006) and has previously been used as a framework for evaluating sustainable development (Brandon & Lombardi, 2011; Jochemsen, 2012; Massink, 2013). The theory of aspects helps to elucidate the connectedness of (change) dimensions and dynamics, and enhances the capacity to create integrated (including cross-system) perspectives to grasp the complexities involved in scaling.

Table 3.2 presents a framework based on the theory of aspects, indicating the particular sequence of aspects with examples of what these aspects pertain to. We have slightly adapted the original suite of 15 aspects and have related it to the notion of 'capitals' as used in agricultural development and resilience studies (e.g. Bebbington, 1999; Berkes & Folke, 1992; Knutsson, 2006; Scoones, 1998; Stokols et al. 2013). The aspects in the framework (Table 3.2) refer to ways in which we experience reality. They are also referred to as distinct perspectives on experienced reality, i.e. on all things (entities, including social structures and events), on the basis of which things and events can be evaluated. They help explain the diversity and coherence of everyday experience, and together they provide an integrative perspective on things and events. They are ordered in a particular way, with each aspect, apart from the quantitative, adding a dimension to the preceding one. For example, the biotic requires the quantitative, the spatial, the kinematic and the physical.

Table 3.2: Aspects in relation to which entities can be characterised

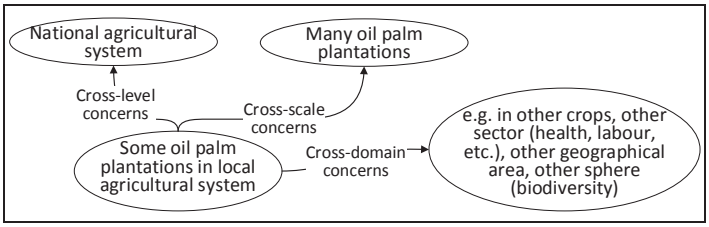
Aspects of experienced reality	What it pertains to	Examples of entities that distinguish themselves from other entities primarily along the lines of that aspect
Natural and physical capital		
Quantitative, Spatial, Kinematic, Physical	Discrete quantity, continuous (spatial) extension, motion, energy, and matter	Numbers, location, atmosphere, climate, water, soil, natural forces, chemistry, transportation, infrastructure, buildings, equipment
Biotic, Sensitive	Non-human life and vitality, feeling	Plants, animals, birds, fish, organic processes, ecosystem, biodiversity, forest, desert, habitat, farm, crops, livestock, animal behaviour
Human capital		
Biotic, Sensitive	Human life and vitality, feeling	Awareness, health, physical and mental abilities, emotion, personality, disposition, passion, observation, population dynamics, safety
Analytical-logical	Distinction	Knowledge, theory, logic, conceptual framework, science, research, education

Aspects of experienced reality	What it pertains to	Examples of entities that distinguish themselves from other entities primarily along the lines of that aspect
Formative	Formative power	Construction, creativity, skill, computer software, design, power (in relationship): technology, strategy, methodology, innovation, adaptation
Social and financial capital		
Lingual, Social	Symbolic representation, social interaction	Symbols, signs, language, communication, information, media Relationships, roles, social cohesion, competition, collaboration, organisation, societies, alliances, partnerships
Economic	Frugality	Resource management, conservation, stewardship, exchange of goods and services, transactions, efficiency, sustainability, economy, land use, market, value chain, firm, employment
Cultural, political and moral capital		
Juridical	What is due	Rights, law, responsibility, appropriateness, policy, legal system, constitution, mandate, police, the state, democracy, ownership
Aesthetical, Ethical, Certitudinal	Harmony Love (self-giving) Faith and vision	Appeal, beauty, enjoyment, leisure, sports, art Attitude, care, sharing, goodwill, integrity, equity, being right, solidarity Identity, belief, trust, faith, vision, commitment, aspiration, worldview, ideology, paradigm

Each aspect has a particular core value and each has its own distinct place in the totality of aspects. No aspect can be reduced to another one, but they are all intrinsically linked (Basden, 2015). An underlying assumption of the theory of aspects is that simultaneously paying due attention to the various aspects supports sustainability. Scientific disciplines usually focus on one or two specific aspects, but complex problems such as those generally related to scaling usually involve many (Schut et al. 2014a, b). The theory of aspects offers a basis for systematically characterising and then comparing technologies, processes, practices and systems along the lines of the aspects. Because this framework based on the theory of aspects allows for such broad-based application, innovation and scaling processes can be analysed across levels, scales, domains and contexts in a consistent manner. Figure 3.5 illustrates some of the analytical boundaries that scaling processes tend to cross.

Thus, combining the theory of aspects with the MLP which is focused on levels and scale helps develop an integrative perspective on what exactly may interact and change in relevant practices and systems as novel technologies and practices go to scale.

Figure 3.5: Scaling processes tend to cross various boundaries — a simple illustration

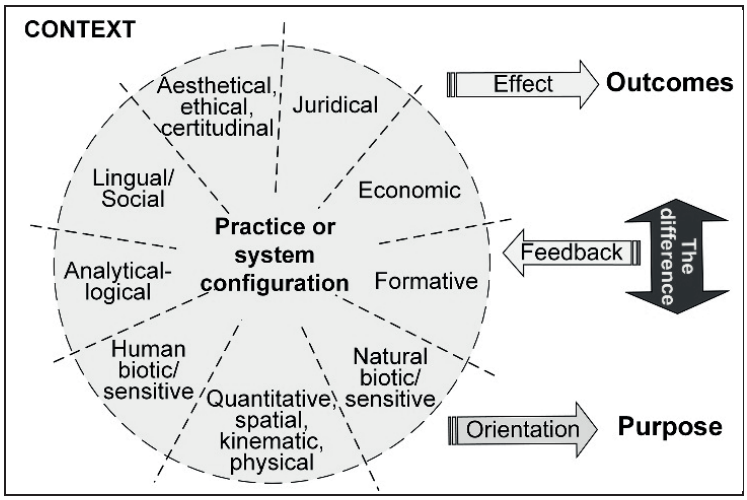


Although technologies, processes, practices and systems function in all aspects, whether part of a niche, regime or landscape, they can be distinguished from one another on the basis of the aspect(s) and its core value that receive prominence in a particular technology, practice, etc. In other words, technologies, processes, practices and systems can be distinguished from each other on the basis of the core value that indicates the very reason of their existence. For agricultural practices, the most prominent feature is usually the efficient application of resources in the production (economic aspect) of goods (food, feed and fuel). In terms of functioning in other aspects, agricultural practices are performed in a particular location (spatial aspect), involve energy (kinematic aspect), involve knowledge (analytical aspect), apply all kinds of technical interventions (formative aspect), involve the use of symbols (including language) to communicate (lingual aspect), have to comply with legislation (juridical aspect), should care about soil fertility and biodiversity (ethical), and so forth. The prevalent conditions regarding all aspects will therefore affect (the performance of) an agricultural practice. For example, a remote location (spatial aspect), little knowledge (analytical aspect) and poor technology (formative aspect) will affect it adversely. Normative perspectives in this context relate to how different people think about how a particular practice is supposed to function in relation to the various aspects.

Technologies, practices and systems are orientated towards a particular purpose: what they are meant to contribute or their reason for existence (the core value of the most prominent aspect). However, subjective choices are involved because actors can decide to perform a practice for their very own reasons. The same applies to systems. A food system may be mainly orientated towards financial benefits (economic aspect) and/or to equitable food distribution (ethical aspect). A mismatch between a (normative) purpose orientation and the actual workings of a system and its outcomes may trigger a feedback loop to adjust the practice or system configuration. For example, agro-ecological niches have emerged because of social movements' dissatisfaction with the dominant farming system (regime) (Duru et al. 2015) that emphasised the importance of one aspect (notably the economic) and forgetting the relevance of others (such as the biotic, social and ethical). Configuration is here understood as the specific way in which a practice or system functions in the various aspects and connects to ideas on dominant designs within regimes.

Applying these idea on purpose and the values behind them to scaling, in which there is an intentional effort to change regime configurations in several aspects, the classification of a technology or practice as good or not is determined by the extent to which all the core values relating to all the aspects are simultaneously realised (Duru et al. 2015; Lamichhane et al. 2015). For example, the use of pesticides to reduce damage caused by insects may be very efficient (economic aspect) but detrimental to environmental and/or human health conditions (biotic, sensitive, ethical aspect). Also, a new technology may present economic advantages, but be rejected for ecological or ethical reasons. Figure 3.6 illustrates this perspective and Figure 3.7 shows how this can be applied to the previously mentioned case of rubber cultivation in China.

Figure 3.6: Creating integrative perspectives on what shapes entities such as practices, systems and institutions



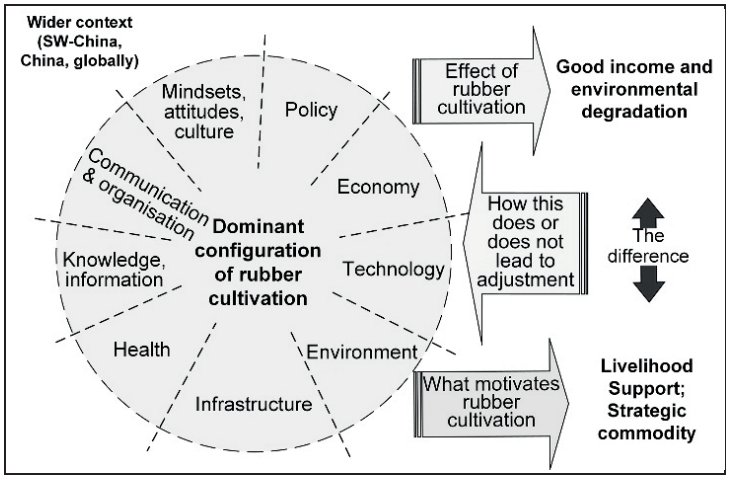
The theory of aspects framework can therefore help alert researchers and decision makers to the fact that agricultural innovation and scaling generally involve trade-offs, as is already recognised in much work concerning scenario building (e.g. Drott et al. 2013; Schwab et al. 2003; Vervoort et al. 2014). Calls for, e.g. inclusiveness (social aspect) and responsible innovation (ethical aspect) address the observed narrowness of some of the previously criticised approaches to scaling, as discussed in Section 1. The theory of aspects framework can help to make trade-offs in scaling visible. Most scaling initiatives involve a range of interactive scaling processes of which decision makers often only gradually become aware as the initiative unfolds. It resembles a Russian doll (matryoshka) that continues to produce smaller dolls as it is opened. The theory of aspects framework can help to articulate what concurrent scaling processes and what particular aspects are involved (Table 3.3).

3.2.3 PROMIS as an integrative analytical framework

In the previous sections, we explained the connection between the MLP and the theory of aspects that highlights the role of pratices, and therefore we refer to the

resulting integrative framework as the Practice-Oriented Multi-level perspective on Innovation and Scaling (PROMIS).

Figure 3.7: Localising the integrative perspective. A simplified example in relation to rubber cultivation in SW-China (adapted from Wigboldus et al. 2017)



The multi-level reference relates to how scaling-related changes in practices play out at the landscape, regime and niche levels. The PROMIS framework uses MLP in a flexible way to enhance opportunities for MLP and the theory of aspects to be complementary and better link to the complexities involved in scaling processes.

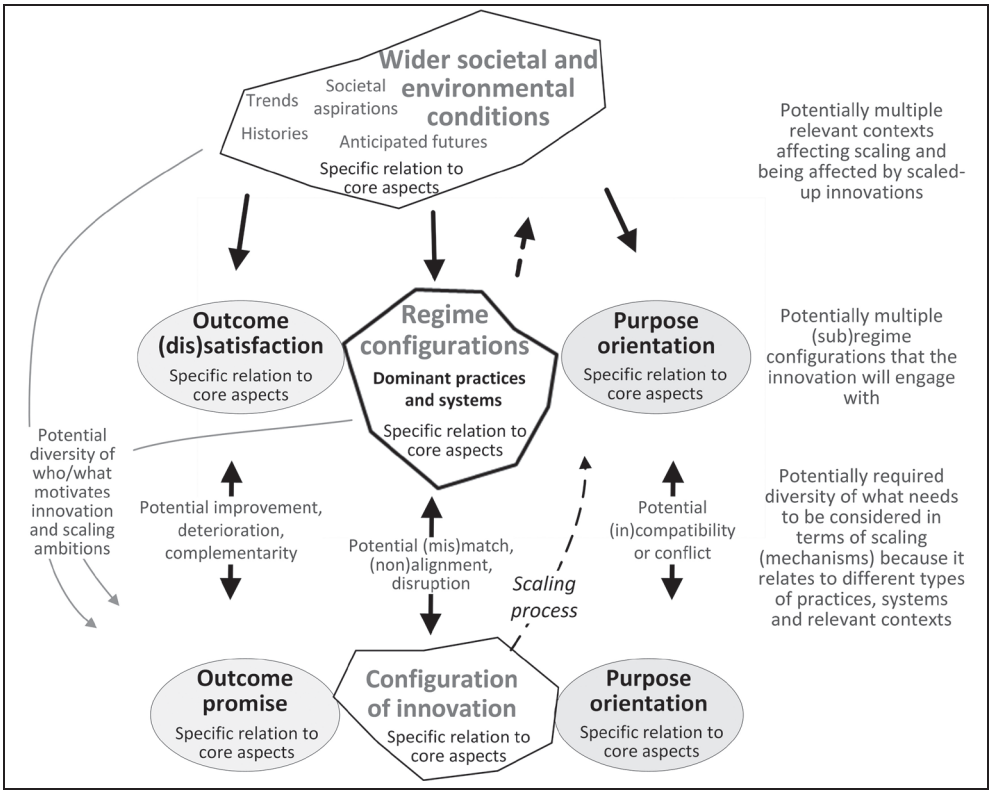
Table 3.3: A scaling initiative often involves a range of interactive scaling processes – an illustration of scaling environmentally friendly rubber cultivation (Wigboldus et al. 2017)

Aspects of scaling	What scaling is involved, both up and down?
Quantitative (more/less)	More farmers involved
Spatial (more or less spread)	Zoning of rubber cultivation plots
Kinematic (faster, more mobile)	Faster dissemination of knowledge about more environmentally friendly practices
Physical (bigger, more encompassing)	Larger project needed to support this
Biotic/sensitive (non-human)	Diversification of cash crops
Biotic/sensitive (human)	Reducing health effects resulting from use of pesticides
Analytical-logical	Increasing knowledge about alternative crops and livelihood opportunities
Cultural-formative	Wider adoption of new practices; adaptation of cultivation plans
Lingual and social	Increasing communication and collaboration between researchers and farmers
Economic	Wider adoption of new business models
Juridical	New policies and legislation stimulating scaling of environmentally friendly rubber
Aesthetic	Landscape beautification through reduced impact of rubber plantations
Ethical	Stimulating wider adoption of “green” mindsets
Certitudinal	Working on increased trust among stakeholders and “green” aspirations

This also means that the multi-level approach can be used to interpret the ways in which scaling relates to different distinctions between levels, such as local, national and global levels (Schut et al. 2014a, b).

Figure 3.8 is a simplified illustration of the type of dimensions and dynamics which the PROMIS framework seeks to unpack.

Figure 3.8: Enriching perspectives on scaling processes by identifying potentially relevant dimensions and dynamics—a simplified perspective



Rather than considering a scaling initiative as a singular movement of innovations from niche-level to regime-level, this perspective suggests the relevance of considering multiple (sub)regimes, contexts and related scaling processes. Taking an innovation to new contexts will expose it to different (types of) dominant systems and practices (regimes). Besides the implications this has for the potential effectiveness of a scaling initiative, it also has implications for potential (lack of) sustainability and opportunities for responsible scaling. The spider-web shapes in Figure 3.8 illustrate differences in configuration in relation to the nine aspects.

The PROMIS framework sensitises researchers and policymakers to potentially relevant dimensions and dynamics involved in the complexity of scaling agricultural

innovations so as to enrich the spectrum of factors to consider in pursuing effective and responsible scaling. In the next section, we explore a number of ways in which the PROMIS framework can be applied.

3.3 Enriching perspectives on scaling processes by applying the PROMIS framework

In this section, we discuss how the PROMIS framework can be applied towards (Section 3.1) analysing the context in which scaling takes place and that it intends to change (regime), (Section 3.2) anticipating the regime changes that the scaling effort may produce, (Section 3.3) understanding how different stakeholders feature in scaling, and (Section 3.4) supporting stakeholders in the future-oriented positioning of scaling initiatives. In the four subsections we suggest ways in which complexities involved in scaling processes may be explored from different angles.

3.3.1 Analysing the regime configuration in which scaling takes place

In this section, we focus on the notion of dominance and deviance, and on stability and rigidity factors involved in regime configurations that are of importance because they determine the context and point of departure for scaling. Dominance of the regime in terms of incumbent and dominant technologies and practices, and deviance of novel technologies and practices, can be interpreted in relation to actors and factors that can be characterised in relation to the suite of aspects. Dominance as well as deviance may, for example, relate to people's aspirations (aesthetical, ethical, certitudinal aspect) or to the dominant use of certain technologies (formative aspect). It may also relate to powerful actors such as industry (economic actor) or government (juridical actor). Or it may relate to formal and informal institutions, such as legal frameworks (juridical aspect) or associations (social aspect). This may involve power issues (Avelino & Rotmans, 2009; Geels, 2014; Olsson et al. 2014). The way in which powerful actors exert influence over the way practices/systems are (re)configured may be characterised along the lines of the suite of aspects. This may involve binding contracts (juridical aspect) or lack of access to credit facilities (economic aspect). Analysis may 'locate' where, i.e. in relation to which aspect/aspects, a niche innovation and the relevant regime are different, non-aligned or in conflict. This clarifies which aspects will need to be considered in scaling.

Routine and stability are to a certain extent desirable features of practices and systems, or in other words, of regimes. Regime stability facilitates fine-tuning and an evolving excellence in performance. Societies require stability for individuals and relationships to thrive. At the same time, they need to adapt to new conditions, capitalise on new opportunities, meet newly defined purposes or counteract adverse effects of the

practice/system. In other words, regime configurations (practices and technologies) are dynamically stable (Geels 2002). As discussed in Section 2, configurations at any level may become locked into a status quo because of rigidity with respect to any aspect, and hence prevent transitions to desired situations: for example, more inclusiveness, sustainability, and diversity of agricultural systems (Elzen et al. 2012; Horlings and Marsden 2011; Stirling 2009, 2011). In terms of scaling, path dependence can be of influence in different ways. One way is through social issues such as resentment over collaboration between stakeholders in the past; another way is through biophysical conditions, for example whether a plot of land has been well-fertilised in the past or hardly fertilised at all over the years, which will affect this year's crop performance (Giller et al. 2011). Given that here people's behaviour is a key element in creating and perpetuating path dependence, the concept of imprinting describes how organisations take on elements of their original/previous environment and how these elements persist (Marquis & Tilcsik, 2013). Similar ideas have been proposed in socio-psychological studies (e.g. Bar-Tal, 2013), referring to people's histories and how their current actions may not connect to current (context) conditions, but to what they experienced in the past. Path dependence and organisational imprinting can also be understood in terms of ceilings (not allowing further expansion), as discussed by IIRR (1999) and Röling (2009, 2011) in relation to institutions and institutional development.

The suite of aspects helps to unpack types of path dependence and imprinting that are relevant for scaling initiatives. These may relate to such different issues as soil depletion (the kinematic/physical aspect), farmers' apathy due to a history of restrictive political regimes (sensitive aspect) and an attitude of indifference (ethical aspect) because people have become used to seeing forests disappear or labourers being exploited. The suite of aspects can help identify so-called lock-ins that may affect scaling, such as for example:

-Formative lock-in, e.g. because dominant use of a particular technology or set of technologies, such as external fertilisers, ploughing and combinations of genetically manipulated seeds and specific herbicides, stipulates what the cropping system looks like

-Juridical lock-in, e.g. because a particular regulation (e.g. ban on GMOs) limits choice options

-Economic lock-in, e.g. because detrimental practices (e.g. use of pesticides) provide private returns in the short run but have negative spill-overs that tend to affect public goods

-Physical/biotic lock-in, e.g. because climate change or soil depletion limits farming options

The need for adaptation and change—and hence innovation in technologies, practices and systems—often relates to stress, which is gradual, and to shock, which is sudden and relates to short-life-span events. Stress and shock relate to what is called the landscape in the MLP, and, as they may induce innovations, they may also be seen as windows of opportunity (Elzen et al. 2012; Geels, 2011). A distinction can be made between different types of stress and shock, which can be characterised in relation to the suite of aspects (Table 3.4). Stress can be ecological, psychological, social, economic and so on. The various stresses and shocks interact: stress or shock in relation to one aspect may trigger a reaction in relation to other aspects. In a systemic perspective, scaling up a novel technology or practice may solve or address a particular stress/shock, while aggravating or introducing other stress/shock factors. Some of these stresses and shocks may relate to power dynamics. An example of this is a powerful company requiring changes in agricultural practices to comply with company standards. Understanding how an envisaged scaling initiative connects to such stress and shock factors can help decision makers to identify appropriate scaling strategies.

Table 3.4: Examples of internal and external stresses and shocks in relation to changing practice/system configurations

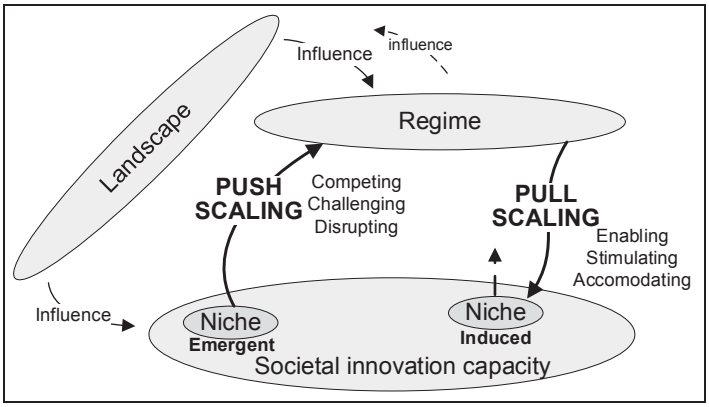
Type of stress/shock	**Unpacking through the suite of aspects**
Incompatibility issues	A new cultivation plan (analytical aspect) does not take into consideration the specific requirements of a particular (hybrid) crop such as increased fertiliser use (kinematic/physical aspect) or training (analytical aspect)
Access issues	Poor access to rights (juridical aspect), services (formative aspect), resources (physical/biotic aspect), or knowledge (analytical aspect) can limit potential functionality of practices/system
Outcome issues	A particular cropping system does not provide the level of income (economic aspect) anticipated/hoped for
Context issues	Climate change and severe weather conditions (kinematic/physical aspect), financial market crisis (economic aspect), changing government regulations (juridical aspect), etc., put pressure on agricultural practices and system
Value issues	Value-based opposition (ethical/certitudinal aspect) to the use of a particular technologies such as GMOs (formative aspect) in a sector

3.3.2 Strategic analysis of anticipated scaling dynamics

In this section, we explore a selection of considerations that we consider to be of particular relevance in strategically positioning a scaling initiative. Metaphorically speaking, a regime may be considered as a kind of iron dome that needs to crack open to allow for an influx (scaling) of novel technologies and practices (push approach). The regime may also be perceived as a magnet that stimulates the emergence of

appropriate novel technologies and practices (pull approach) which are in line with (emerging) purpose (re)orientations. Depending on situation specificities, different innovation and scaling approaches and related policies and interventions can therefore be considered. Figure 3.9 illustrates this.

Figure 3.9: Distinguishing between different types of scaling initiatives in a simplified MLP view



The first approach (push) takes for granted the value of the technology or practice (e.g. higher yielding crop variety) to be scaled up and focuses on uptake and adoption. The second approach (pull) sets a benchmark (vision) for what innovation and associated scaling processes need to contribute and connect to, and focuses on reorienting system values towards this, i.e. some players such as policymakers within the regime may assist niches to make changes and disrupt the regime (Alrøe & Kristensen, 2002; Kivimaa & Kern, 2016; Mitchell et al. 2015). For example, a sector policy regarding sustainable energy may stimulate the scaling of new sustainable energy technologies through tax exemptions and subsidies. MLP was developed mainly to understand processes involved in radical innovation and scaling (push), and developing related management approaches such as strategic niche management. It is important to expand views on scaling to prevent a sole focus on 'pushed scaling' (make things go to scale by supporting niche expansion), whereas 'pulled scaling' (help things go to scale by changing regime conditions) may in fact be a much more common (and often more appropriate and effective) approach. However, the latter approach is not often thought of sufficiently when a scaling initiative is being considered (Geels, 2014; Kivimaa & Kern, 2016). Our literature review thus leads us to conclude that scaling agricultural innovations (novel technologies and practices) is generally understood as a process of making agricultural innovations go to scale through a push approach. This limits the scope of strategic options considered, in line with the previously discussed criticisms on dissemination and diffusion approaches. Hence, the development of systemic perspectives needs to translate into a variety of strategic options for engaging with system dynamics at both niche and regime level. The use of systemic perspectives will be of little use if the mode of engaging with complexity is rather singular. In terms of considering such complexity, and building on the idea of push scaling, pull scaling

and interventions, it is relevant to consider that some scaling processes are actively pursued but many happen anyway, without being actively pursued. Scaling processes are part of nature and society, and they happen constantly with and without deliberate action. For example, weeds and pests go to scale without anyone putting a conscious effort into making this happen. Any envisaged scaling initiative will need to be positioned within the bigger picture of wider scaling processes (including landscape trends). Scaling initiatives may also trigger new scaling processes. The wider application of a particular crop variety and planting it as a monoculture may trigger the scaling of certain pests and diseases. Also, scaling up the application of one particular practice will often involve or even require the scaling down of other practices. It may further require associated scaling processes such as scaling up the application of specific knowledge to enable a new practice to be performed properly. Figure 3.10 illustrates how it is often necessary to position a scaling initiative within such wider dynamics of ongoing and emerging scaling processes and related trends and developments.

3.3.3 Understanding different stakeholders' roles in scaling

Scaling processes involve a range of stakeholders related to both niches and regimes. The suite of aspects can be used in a number of ways to develop a systematic understanding of these stakeholders. Firstly, the aspects can be used to distinguish between types of stakeholders who are involved in terms of what aspect characterises their core practices, and hence their interests. This may prevent an undue focus on particular objectives of scaling, related to, for example, economic interests. Secondly, the aspects can be used to characterise the core motivations (or purpose orientations) of stakeholders in terms of what drives stakeholders' decision making. This may, for instance, be technology-driven (emphasis on the formative), market-driven (emphasis on the economic), policy-driven (emphasis on the juridical) or service-driven (emphasis on the ethical). Although usually less pronouncedly, it will often also reflect individual and group identity, style and preference (relating to aesthetical, ethical and certitudinal aspects) where, for example, farmers' choices relate to more than rational optimisation of assets and utility maximisation (e.g. Bell et al. 2004; van der Ploeg, 1993). Thirdly, the suite of aspects may be used to identify the variety of ways in which practices, systems, and their effects are evaluated by stakeholders. This includes understanding how comprehensive their views of effects are: they may not be aware of, or not pay attention to, certain effects that relate to particular aspects, and hence may not be able to negotiate convergence in multi-stakeholder processes (Leeuwis, 2000).

Stakeholder dynamics play out at different levels of decision making and governance. Decision making in relation to a single practice (e.g. a cultivation task) is to a certain

extent determined in a limiting or facilitating way by how the farming system as a whole is governed, and we may characterise this interaction along the lines of the suite of aspects. The same goes for the relationship between a farming system and the wider agricultural sector or value chain and policy and regulatory system in which the farming system is embedded. The PROMIS framework can thus be used to organise an overview of actor perspectives in the light of an envisaged scaling initiative, such as in terms of what different stakeholders think are the most important/relevant aspects to be considered in the initiative. It may also be used to consider how this initiative may affect stakeholders in different ways, such as in relation to gender and diversity issues (children, physically challenged people, minority groups, social classes) or in relation to power issues regarding who/what drives or benefits from the scaling initiative (Bailey, 2011; Leach et al. 2010; Melber, 2012; Stirling, 2009, 2011).

3.3.4 Supporting stakeholders in future-oriented analysis of scaling

As regards the ultimate potential of technologies, scaling processes may set things in motion in a way that was not fully anticipated, in terms of both positive effects (Geels 2001) and negative effects (Gee et al. 2013), as highlighted in Section 3.1. The suite of aspects can inform foresight exercises, which activate cross-temporal perspectives, so that the scope of, e.g. scenario analysis will be appropriately inclusive (e.g. Barakatt et al. 2010; Foresight, 2011; Nelson et al. 2010; Paillard et al. 2014; Vervoort et al. 2014).

While scaling processes originate from within particular system and domain boundaries (e.g. cropping system, value chain, sector), they tend to affect, and be affected by, factors that lie beyond the boundaries of the systems, domains and levels that are the focus of a scaling initiative (Figure 3.10), and thus involve and impact stakeholders at different scales and levels in systems. This involves all kinds of complexities. What is good from a private-sector perspective (private goods) will not necessarily be considered good from a public-sector perspective (public goods). Also, scaling may result in a growing disconnect between purpose orientations and outcomes (van der Ploeg, 2006), such as farmers losing sight of the effects of pesticide use if they no longer eat (some of) their own produce when they become market oriented. Similarly, a sector, value chain or multinational may not incorporate effects of scaling up the application of certain products, processes, or practices in its decision making because negative effects take place in another domain (e.g. the environment or health) and/or another geographical area (Milder et al. 2014; Sayer et al. 2014). Finally, from, e.g. a sector perspective, scaling can be considered to have positive impact, but it may not work out well for all groups and individuals in it, which points to the need for inclusive perspectives on scaling

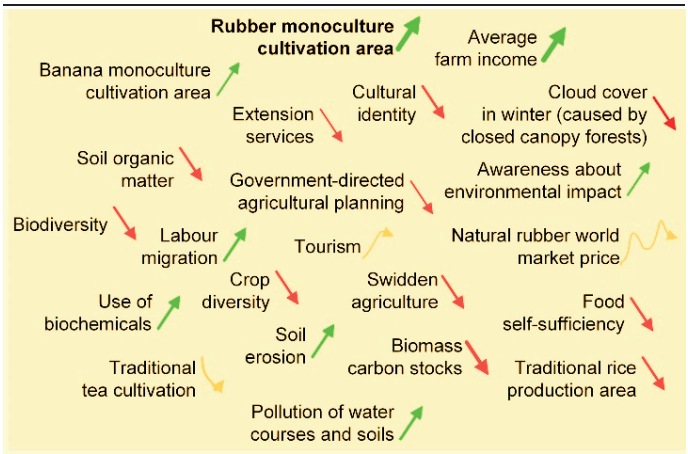


Figure 3.10: Positioning scaling initiatives in a context of simultaneously occurring scaling processes. Example of scaling environmentally friendly rubber practice in SW-China (adapted from Leeuwis & Wigboldus, 2017)

This calls for activating cross-scale and cross-domain perspectives (Yu et al. 2012) in scaling, making use of existing information relating to different scales and bringing together researchers, stakeholders and decision makers from across levels and domains (Borgström et al. 2006; Cash et al. 2006; Cumming et al. 2006, 2012; Loveridge, 2009; Padt et al. 2014) to inform responsible scaling by anticipating undesired effects or unintended effects at scales, levels and domains that are not supposed to be affected by the scaling effort. Foresight exercises through scenario analysis can enrich the theories of change that are commonly articulated for scaling initiatives (e.g. Adekunle & Fatunbi, 2014; Arkesteijn et al. 2015).

Applying foresight approaches to the context of scaling thus involves scenario analysis addressing the question 'what if this goes to scale?' For example, such analysis may involve anticipating what a wider application of a particular cropping system would mean for markets (economic aspect), the environment and nutrition (physical and biotic aspect); how it might interact with wider technological trends and developments (formative aspect) and how it would connect to societal concerns (aesthetical, ethical, certitudinal aspect). Foresight exercises and scenario analysis may involve risk and trade-off analysis (e.g. Guillem et al. 2015; Komarek et al. 2015) and social and environmental impact assessment, or be supported by participatory modelling and companion modelling in which stakeholders are included as active participants (Bousquet et al. 2005; Delmotte et al. 2013; Gouttenoire et al. 2013; Sandker et al. 2010). Foresight exercises may be guided by the suite of aspects articulated in the PROMIS framework, which also can be used as a checklist to consider what kinds of assumptions underpin envisaged scaling initiatives, or to consider in modelling exercises what must be part of the model and in what way.

3.4 Using the PROMIS framework as an integrative tool in research: early experiences

In Sections 2 and 3, we explored opportunities for enriching perspectives on scaling processes. Table 3.5 illustrates how different elements, discussed in those sections, can be combined towards creating an integrative perspective on a particular scaling initiative while indicating the type of analytical tools that may be used for this. The columns relate to the topics explored in Sections 2 and 3. These are summary descriptions and do not reflect the full scope of possible questions to guide analysis.

Table 3.5: Developing integrative perspectives on scaling initiatives

	Research questions from related sections in this paper (some examples)								
	2.2	3.1	3.1	3.1	3.1	3.2	3.3	3.3	3.4
Micro view on the nine aspects	Where are potential cross-scale and cross-domain effects located?	What histories matter and how?	Where is potential for change located?	Where is practice / system inertia/ lock-in located?	Where is dominance and deviance located?	What are relevant context aspects and dynamic?	Where are important drivers of decision making located?	Where are stake-holder interest, power, etc. located?	What are relevant trends; what if this goes to scale?
	↓	↓	↓	↓	↓	↓	↓	↓	↓
Disciplinary perspectives on e.g. the individual, household	→	**An integrative and interdisciplinary perspective relating to the nine aspects**: Connecting micro and macro (multi-level) perspectives; Connecting disciplinary perspectives; Connecting research questions and methods							←
	↑	↑	↑	↑	↑	↑	↑	↑	↑
	Social-ecological analysis	Process tracing	Institutional analysis; Force-field analysis	Political economy analysis	Soft systems methods	Decision making/ risk analysis	Stake-holder and power analysis	Scenario and foresight analysis	
	Types of relevant methodological options (some examples)								

Macro view on the nine aspects

Disciplinary perspectives on e.g. the system, sector, and landscape

The variety of suggested methodological options follows pleas to use mixed methods and mixed approaches for research and evaluation (Johnson & Onwuegbuzie, 2004; Garcia & Zazueta, 2015) in order to enrich perspectives and to compensate for limitations of particular methods and approaches. Single actors will rarely have a complete view of, let alone a mandate and/or control over, the multi-faceted dimensions and dynamics involved in agricultural scaling processes. As Table 3.5 shows, the PROMIS framework can help in determining the use of an appropriate mix of methods and approaches for coherent analysis, depending on the several questions to be addressed, and hence support interdisciplinary analysis and integrated policy making.

However, in many cases, it will not be feasible nor even desirable to apply the fully-fledged integrative perspective on each scaling initiative as presented in Table 3.5. On the basis of existing knowledge and estimated risk levels involved, a selection of initial focus points and research methods connected to these can be made (e.g. zooming in on variations in what informs farmer decision making). This appears a contradiction, as the PROMIS framework is intended to broaden perspectives on scaling. When the use of the PROMIS framework is being tailored to a particular situation, appropriate and feasible levels of comprehensiveness of analysis need to be decided on. However, the PROMIS framework can serve here to elucidate relevant issues that were originally not considered by the scaling effort. Also, an initial wide-ranging assessment may be done in the form of a quick-scan study, after which a more focused analysis can be conducted in relation to selected aspects that are deemed most pertinent. So far, we have operationalised the PROMIS framework in three different case studies involving three different application approaches (see Table 3.6).

Table 3.6: Initial operationalisation of the PROMIS approach

Case 1: An exploratory study on scaling up environmentally friendly rubber practice in SW-China (Wigboldus et al. 2017).
Application of the PROMIS approach by using: - the framework to focus a literature study so as to identify how the relevant range of factors and related dynamics affect opportunities for making rubber cultivation environmentally friendly; - the framework to consider how stakeholders relate to particular aspects and to decide whose perspectives and roles would be particularly important to take into account; - the framework to develop a semi-structured questionnaire in relation to pertinent issues and to ask a range of informants to score pertinent issues (relating to the aspects) in terms of relevance, of what locks in current rubber cultivation practice, and of what creates opportunities for change (results were expressed in a spider diagram to create an overview and allow for quick comparison); - soft systems methodology (rich picture) in interactive stakeholder processes to reflect on the integrated nature of issues (Checkland & Sholes, 1999); - the resulting overview to consider what would need to be addressed and how, and who should be involved in what way if the objective was to scale up environmentally friendly rubber practice.
Case 2: Providing a broad systemic perspective on factors involved in scaling up agro-ecology practice in Nicaragua while focusing on household-level decision making within that bigger picture
Application of the PROMIS approach by using: - similar elements as the above, but then in relation to multiple workshops and wider consultation with stakeholders; - using additional household-level surveys in which questions derived from the value–belief–norm theory (e.g. Stern 2000) were used to assess decision-making processes; - connecting macro (bigger picture) perspectives with micro (farmer decision making) perspectives to create a multi-dimensional framework for decision making.
Case 3: Guiding retrospective analysis of a scaling initiative: a study on the scaling and institutionalisation of cocoa farmer field schools in Cameroon (Muilerman et al. 2018)

The study involved the development of a narrative description, both chronologically and along the lines of MLP. This narrative description was subsequently analysed in relation to a PROMIS perspective in two ways:
- in terms of the extent to which aspects played a specific role in the disappointing outcomes of the scaling iniative;
- in terms of what dynamics played what role in the disappointing outcomes of the scaling initiative by considering the dynamics as discussed in section 3 of this paper.

The first two studies provided input into strategy development for the envisaged scaling initiative regarding both the range of interactive factors and dynamics that would need to be taken into account and stakeholders' perspectives on how this could be done. The third study identified key reasons for the scaling initiative's disappointing outcomes at individual and systems level, including relevant learning for other scaling initiatives. By applying an uncommonly broad perspective on dimensions and dynamics involved in scaling processes, the PROMIS framework helped to identify important clues that other analytical approaches tend to miss because they explore within a particular domain of change only. This includes providing a framework for considering what makes for responsible scaling.

We can illustrate this in the case of green rubber: research findings pointed, among others, to the need to broaden perspectives on what is involved in scaling 'green rubber' practice from a dominant focus on exploring 'technical' options (e.g. adapting/diversifying rubber cropping system), to the inclusion of the role of institutional and paradigmatic constraints and opportunities. The findings also highlighted the need to consider required changes in rubber cultivation in a wider landscape perspective to prevent shifting problems from rubber to those caused by, e.g. the scaling of banana cultivation.

These two examples highlight that applying the PROMIS framework indeed enables a richer perspective on scaling; however, further development of PROMIS to serve as a research tool is needed as we will discuss in the next section.

3.5 Conclusion: current contribution of PROMIS and next steps

At the start of this paper, we argued that common approaches to scaling, using concepts such as dissemination, diffusion, adoption and transfer of technologies and practices, are not sufficient to grasp the complexities involved in scaling processes. As a result, decision makers often do not have a sufficiently broad picture of what they need to prepare for, and engage with, in scaling initiatives. This limits policies, strategies and guidance of scaling initiatives from becoming both effective and responsible in the light of societal values and aspirations.

We seek to contribute to addressing this gap by introducing PROMIS as an integrative analytical framework that can contribute to the heuristic exploration of relevant dimensions and dynamics involved in innovation and scaling processes. The PROMIS framework raises awareness about the multi-faceted dimensions and dynamics to be considered in scaling initiatives. The underlying systemic frameworks (MLP and the theory of aspects) provide a coherent reference framework that can be made operational through application of specific methods and methodologies. The PROMIS framework can help in appropriately informing scaling initiatives in the light of core dimensions of responsible innovation: being anticipatory, responsive, inclusive and reflexive. We may therefore consider the PROMIS framework to support a capability for responsible innovation and scaling.

In projects which include a clear scaling ambition, operational theories of change rarely include an articulated 'theory of scaling' (how scaling is expected to happen) nor a clear perspective on 'what if this goes to scale?' (including potential negative implications of particular innovations going to scale). This thus goes beyond installing mechanisms which may foster scaling by establishing enabling conditions for scaling such as local adaptation processes (Millar & Connell, 2010), and innovation platforms working on a match between technologies and a conducive institutional and market environment (Kilelu et al. 2013) or diffusion mechanisms such as mobile phone based information services (Aker, 2011; Baumüller, 2016). It would be about defining such a theory of scaling in a systematic way (see Chapter 6). The PROMIS framework can help in drawing up such a theory of scaling by alerting those who have primary responsibilities in design and management of such initiatives by helping to address strategic questions such as:

Do we need to be more critical about this scaling initiative, for example regarding who really benefits or what potentially negative effects at scale may result? This relates to dimensions of responsible innovation and scaling, and perspectives on sustainability, beyond seeking technical 'fixes' (Brandon and Lombardi 2011). It also relates to debates regarding the role of diversity and how scaling initiatives may reduce this, thus allegedly leading to increased vulnerability (Leach et al. 2012).

Do we need to be more creative in devising scaling strategies? We may, for example, need to choose to focus more on creating conditions for scaling rather than on actively trying to make something go to scale (Leeuwis & Aarts, 2012; Westley et al. 2014; Wigboldus & Leeuwis, 2013). It may also involve considering a range of potential leverage points (entry points) in terms of places to intervene in systems (Meadows 2009). This may, for example, lead to the adjustment or broadening of a strategy from a focus on scaling new cultivation practices, to addressing organisational and institutional prerequisites for sustainability.

Do we need to be more co-creative in the scaling initiative? This may require the forging of supportive partnerships (Aldrich, 2011; Bhowmick, 2015; Faustino & Booth 2014; GEO, 2011; Klein Woolthuis, 2013), such as innovation platforms, networks or labs (e.g. Kieboom, 2014; Kilelu et al. 2013; Schut et al. 2015a, b; Tenywa et al. 2011; Unicef, 2012). Initiatives such as SUN (http://scalingupnutrition.org/) and GAIN (http://www.gainhealth.org/) are good examples of collaborative scaling initiatives.

Do researchers need new competencies to engage effectively and responsibly with scaling processes? Disciplinary research is often well-equipped to highlight tensions between functions within an aspect. For example, agronomic research can assess whether a new hybrid may perform well in terms of soil, not so good in relation to pathogens, better in relation to climate, and so on. In scaling, however, new concerns open up that need to be explored, but that often fall outside the scope of such more focused research. This means that it will often become much more than an agronomic innovation and scaling process, requiring broader expertise and competencies. We would therefore argue that a process of innovation and scaling has to be approached as an interdisciplinary or transdisciplinary endeavour. This may also involve new roles for researchers, combining an expert role with a role of facilitating collaborative processes (Brouwer & Woodhill, 2015; Hermans et al. 2013; Schut et al. 2011; Spruijt et al. 2014; Turnhout et al. 2013; Wittmayer & Schäpke, 2014), and this will also require that an enabling environment is created as existing procedures, incentive systems and funding mechanisms may work against such new roles (Roux et al. 2010; Turner et al. 2016).

Initial applications of the PROMIS framework in research created awareness about, and helped to unpack, complexities involved in scaling initiatives. One of the case studies demonstrated how a resulting integrative perspective can inform scaling strategies, and another case study showed how the PROMIS framework can be used in the retrospective analysis of a scaling initiative.

In this paper, we sketched the contours of an integrative framework to enrich perspectives on and analysis of scaling processes and discussed initial empirical testing. However, experiences with the PROMIS framework as a research tool are tentative, and we invite scholars to further develop it, since as the framework is tentative, it needs further grounding. Further research may pursue two directions: further elaboration of the PROMIS framework to strengthen its conceptual grounding (e.g. in relation to the interactions between aspects), and further field testing and refining to make it more suitable for providing practical research and decision-making support. More research is needed to validate the analytical lenses within the PROMIS framework and underpin it with empirical studies. Also, further development of more precise indicators and criteria is needed to measure the several aspects of scaling, as

well as to measure their interrelationships, causalities and possible synergies and emergent effects.

From a practical perspective, policymakers in particular would benefit from the further development of the PROMIS framework into a reflexive decision support tool to guide responsible innovation and scaling. This would include development of a methodological approach on how to articulate a theory of scaling (assumptions regarding how scaling is expected to happen) to guide decision makers in (innovation) projects that have a clear scaling ambition. The challenge and perhaps trade-off and tension in such follow up work will be not to lose the holistic perspectives of PROMIS and in effect go back to single discipline oriented, reductionist ways of analysing scaling processes.

Acknowledgments

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CHAPTER 4

Scaling green rubber cultivation in Southwest China.

An integrative analysis of stakeholder perspectives

4

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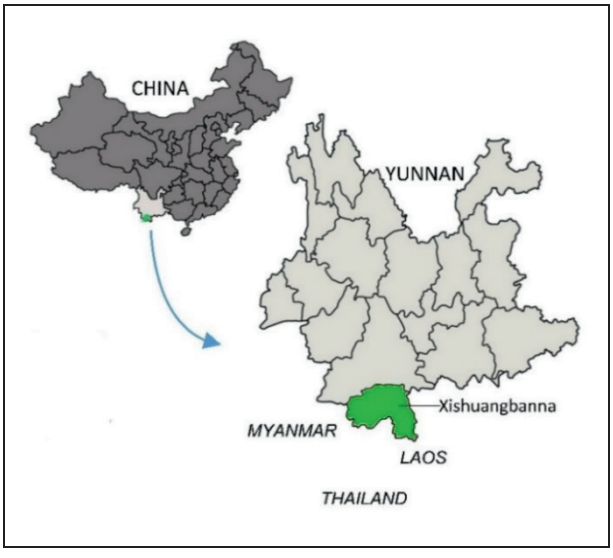
4.1 Introduction: the need to 'green' rubber cultivation

The greening of agriculture, which is about making agriculture more ecologically and socially sustainable, is a topic of much study and debate across the globe (e.g. EEA, 2012; FAO, 2012; Scherr et al. 2015; UNEP, 2011). This includes the role of agriculture-forest landscapes in climate change mitigation (Agrawal et al. 2014). The concept of 'green' rubber relates to this, implying notions of reduced negative environmental and socio-economic impacts resulting from the cultivation of natural rubber. The rapid expansion of rubber crops, especially in Southeast Asia and Southwest China (e.g. Xu et al. 2014), has led to widespread replacement of biodiverse landscapes with monoculture plantations (Fox et al. 2014; Warren-Thomas et al. 2015). The concerns raised are similar to those relating to other tropical monocultures such as oil palm (Clay, 2004; Fitzherbert et al. 2008) and in broader terms are associated with the effects of expanding agriculture (e.g. Laurance et al. 2014). The negative environmental and social impacts of expanding rubber plantations have become a focus of much study (Ahrends et al. 2015; Mann, 2009; Ziegler et al. 2009) culminating in the push for a robust sustainability initiative to mitigate impacts on tropical biodiversity and social conditions (Warren-Thomas et al. 2015).

This study focuses on the autonomous prefecture of Xishuangbanna, in Yunnan, Southwest China (Figure 4.1), where the effects of rubber cultivation include extreme loss of ecosystem services (Hu et al. 2008), including a loss of 80 million tons of biomass between 1976 and 2003 (Li et al. 2008). This involves, among other things, a reduction in structural and functional biodiversity (Zhou et al. 2012), reduced carbon sequestration (Xu et al. 2014; Yang et al. 2016), alteration of hydrological systems (Liu et al. 2014), soil erosion, and loss of soil carbon stocks (de Blécourt et al. 2013; Liu et al. 2011; Li et al. 2012), as well as detrimental effects on living organisms (Zheng et al. 2015) and even on the local climate (Zomer et al. 2014).

Figure 4.1: Location of Xishuangbanna in Yunnan province, China (adapted from Croquant, 2007)



At the same time, positive socio-economic effects of the rubber boom have been substantial, lifting many people out of poverty and even

leading to considerable wealth for many smallholders, especially in the lowlands (Hammond et al. 2015; Waibel & Huang, 2014; Grötz, 2016). However, as income from rubber rose, food crop lands were replaced and food now needs to be mostly imported; this has increased livelihood risks and vulnerability (Fu et al. 2010; Waibel & Huang, 2014; Xu et al. 2014). Beyond degradation of soils and water sources, such vulnerability relates to economic dependence on rubber and the fact that between 2011 and 2015 market prices for natural rubber collapsed, with uncertain prospects of rising again (Warren-Thomas et al. 2015). Yet, likely scenarios for the future of rubber in Xishuangbanna include the possibility of significant further expansion, or conversion to other monoculture crops such as banana (Yi et al. 2014).

These negative effects on ecological and socio-economic sustainability have led to a broad-based agreement among government, researchers, farmers, and plantation managers that the current situation regarding rubber cultivation in Xishuangbanna is unsustainable. Therefore, actions have been undertaken to address its causes, to at least prevent further deterioration and if possible reduce the burden of rubber on the landscape. Researchers have explored a range of approaches involving alternative technologies, practices, and policies to solve the problem of unsustainable rubber practices. Some research focuses on improved plantation practices (de Blécourt et al. 2014; Li et al. 2013) in terms of yield intensification, mixing rubber trees with other trees (crops) or improved undergrowth to reduce surface erosion. This also involves capacity building among indigenous people, which would enable them to cope with environmental variability and socio-economic change (Xu et al. 2005; Yi, 2014). Other research aims at finding options for alternative livelihoods to offer ways out of rubber dependence, e.g. livestock or high-value tea cultivation (e.g. Riedel, 2014; Zhang et al. 2014) or at creating opportunities for the local population to benefit from tourism (Wen, 2014). Currently, the owners and organisers of the tourism business tend to be Han Chinese people from outside Xishuangbanna, and the profits from such tourism flow out of Xishuangbanna. Given that Xishuangbanna is a biodiversity hotspot, some research has suggested systematic valuation of ecosystem services (Xi, 2009) and appropriate compensation mechanisms (He & Sikor, 2015; Thapa et al. 2014), including in relation to carbon trading (Fox et al. 2014; Yi et al. 2014). Still other research pleads for a more encompassing approach through a reform of Chinese environmental policies to better respond to major changes occurring in relation to ecosystems, food security, energy, water, and climate change (Grumbine and Xu, 2013).

Despite the large number of publications presenting options for green rubber cultivation, most research tends to focus on biology, hydrology, meteorology, ecology, soil science, and on related technical solutions (often with a specific focus on one of the disciplines) and pays less attention to the integration of these disciplines coupled with analysis of social and economic dynamics that would be involved in decoupling

the rubber sector from its unsustainable course. Such dynamics include the hierarchical relationship between the Han Chinese and other ethnic groups prevalent in Xishuangbanna, as documented by Sturgeon and Menzies in relation to rubber cultivation (e.g. Sturgeon & Menzies, 2006). As Sturgeon and Menzies argue, this socio-cultural dimension of rubber cultivation tends to be left out of discussions on sustainability, although it has played and continues to play a key role. Hence, there have been a number of calls for more integrative and interdisciplinary assessments (Aenis et al. 2014; Cotter et al. 2014; Herrmann & Fox, 2014; Xu et al. 2014) and for participatory landscape scenario definition (Aenis and Wang, 2014).

This paper responds to these calls in the literature, providing an analysis to inform sustainability-promoting initiatives to support scaling in terms of geographical spread and total number of adopters of sustainable technologies and practices, as well as scaling in the form of increased institutional support for green rubber in policies, incentives, and markets (Wigboldus et al. 2016; Hermans et al. 2016). Beyond providing knowledge for the context of rubber cultivation in Southwest China, this analysis can provide insights that can inform developments in the broader region, because knowledge generally flows from Xishuangbanna towards Cambodia, Laos, and Myanmar (Sturgeon, 2013), which are frontiers of expanding rubber cultivation (e.g. Fox et al. 2014; Global Witness, 2014; Liu et al. 2013; Woods, 2012). The greening of rubber cultivation in Xishuangbanna could therefore have beneficial knock-on effects.

4.2 Research methodology: applying the Practice-Oriented Multilevel perspective on Innovation and Scaling

Using the Practice-Oriented Multilevel perspective on Innovation and Scaling (PROMIS) framework (Wigboldus et al. 2016), we mapped multiple factors relating to rubber cultivation and the associated impacts. This framework was specifically developed to help create integrative perspectives on the scaling of agricultural innovations. In this case, green rubber is the innovation to be scaled, in order to reverse the current negative effects of rubber cultivation. PROMIS builds on a systemic model that has been used more widely to evaluate sustainability in the built environment (Brandon and Lombardi, 2011) and to assess factors involved in scaling sustainable technologies, practices, and policies (Wigboldus et al. 2016). It builds on the multilevel perspective developed by Geels (2002), which has been used widely in the context of agricultural sustainability studies (e.g. Ingram, 2015; Hermans et al. 2016). Figure 4.2 is an application of this perspective to the case of rubber in Southwest China (in a simplified presentation). PROMIS helps unravel different dimensions of the current rubber cultivation system that keep it from becoming more sustainable

and that affect the scaling of technologies, practices, and policies. It alerts research to the need to identify how a variety of dynamics in scaling interact, simultaneously stimulating change and locking current practice into its unsustainable mode.

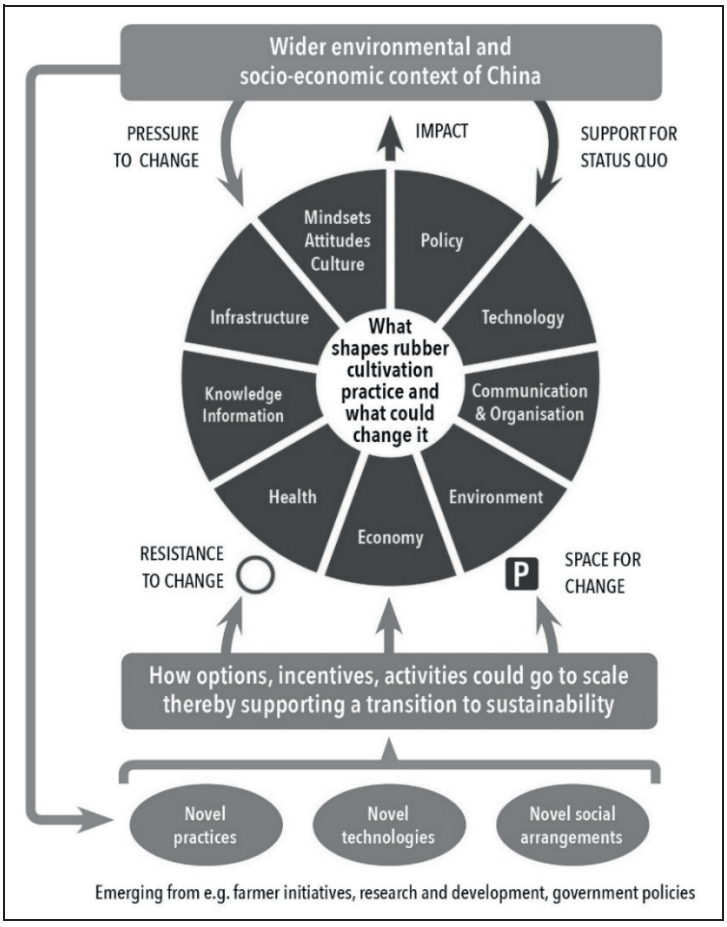


Figure 4.2: An integrative perspective on multilevel dynamics that have implications for opportunities to make a transition to a more sustainable rubber sector (adapted from Geels, 2002). The dominant system of unsustainable rubber cultivation is composed of different dimensions that need to be tackled and would involve scaling of alternative technologies, practices, and policies relating to those dimensions to support green rubber cultivation. This informs research questions such as 'how do stakeholders view relevant dynamics in terms of their capacity to constrain or support a transition to sustainability by scaling sustainable technologies, policies, and practices?', and 'how can stakeholders engage with these multiple factors in a sustainability initiative?'

The PROMIS framework was used to structure our analysis (notably in defining research questions and the choice of methods to be used in facilitating a multi-stakeholder workshop) as well as to interpret findings (notably in identifying the relevant 'force field' of factors that support or constrain a transition to more sustainable rubber cultivation practice). The research involved two main elements: 1) obtaining individual perspectives from informants representing views of different stakeholder groups through semi-structured interviews with key informants and 2) facilitating a multi-stakeholder perspective through a one-day interactive workshop attended by 12 informants from 10 different organisations connected to six

different stakeholder groups (involving some of the same informants interviewed as well as additional informants). The selection of informants was based on an open call at a conference on land use and development in Xishuangbanna, which had 60 attendees from different sectors (Hammond, 2014), and on purposeful and snowball sampling via the professional networks of the co-authors of this paper, three of whom have worked in Xishuangbanna for at least ten years each. Key informants were selected from the realms of science (national and international knowledge institutes), environmental policymakers, NGOs (community development), business (including state rubber companies), and smallholders (villagers) who could represent viewpoints of important stakeholder groups on the topic of green rubber and therefore help inform an integrative perspective using the PROMIS framework. Interviewees were selected on the basis of expertise with the topic and of actively working on that topic – i.e. they were personally or professionally invested as stakeholders. This included experts who have published on rubber cultivation and its complications in Southwest China from various angles, most notably from the Centre for Mountain Ecosystem Studies (CMES).

Through 18 semi-structured interviews with key informants and the one-day workshop with some of the same and some additional informants, we explored how green rubber is interpreted and perceived by different stakeholders in Xishuangbanna in Southwest China, and discussed opportunities and impediments to scale unsustainable rubber management practice. Interviews typically lasted for 1 h, and translation was used when necessary. The selection of questions to be used in interviews and the workshop was informed by an extensive review of academic literature and grey literature, using Scopus, Bing, Google, and Google Scholar search engines, also relying on local contacts to provide insights into the local language grey literature and on discussion with scientific experts at CMES. At the end of the interview, we showed informants a list of various dimensions relating to rubber cultivation practices and asked them firstly how important on a scale of one to five they felt each one was in stimulating or constraining change, and secondly to select the dimensions for which they felt local capacity was weakest. The dimensions were based on the nine core aspects shown in Figure 4.2.

The morning workshop session centred around collaboratively defining green rubber, using a grid based on levels (e.g. farm level, village level, landscape level) and degrees of green (e.g. slightly green, very green). The grid content had been inspired by interview discussions. Participants were, however, encouraged to redefine the categories as they saw fit and to engage in discussion with other participants. The afternoon session used the 'rich picture' technique (Checkland and Scholes, 1999). Participants were asked firstly to draw the Xishuangbanna landscape as it is today and then to superimpose things that would need to be different if green rubber were to

become widely adopted. There was a final closing discussion for the day in which tentative conclusions on the outcome of both the morning and the afternoon session were exchanged. The workshop was highly interactive and facilitated in Mandarin.

Initial descriptions and findings from the interviews and workshop were cross-checked with CMES researchers who have conducted extensive research on rubber cultivation in the past. They had only minor comments. We also found the findings to be consistent with the literature studied as part of this research. In the following, we present key results from the study and explore implications for further research and for connecting the integrative perspectives thrown up by our study to opportunities for change in Xishuangbanna and beyond.

4.3 Results part 1: perspectives on green rubber

Green rubber – or sustainable rubber – is a relatively new term (e.g. van den Beemt, 2011; World Agroforestry Centre, 2016), and its interpretation differed between stakeholders. Through the interviews and workshop, we facilitated a consensus on the criteria for green rubber and the changes required in practices, technologies, and policies (see Table 4.1). According to informants, these changes would need to take place at different levels: plot/farm level, village level, and district/prefecture level, the latter relating to the wider landscape in Xishuangbanna. Informants distinguished between different degrees of aspired sustainability gains in the process of greening rubber cultivation, and informants themselves drew up a classification scheme during the workshop, ranging from 'light green' (limited sustainability gains) to 'dark green' (large sustainability gains), to clarify the type of activities to be expected. It was recognised that, in order to achieve true sustainability, deep changes that might initially seem undesirable were required, and so a route from 'light green' to 'dark green' was described.

4.4 Results part 2: constraining and enabling factors in scaling green rubber

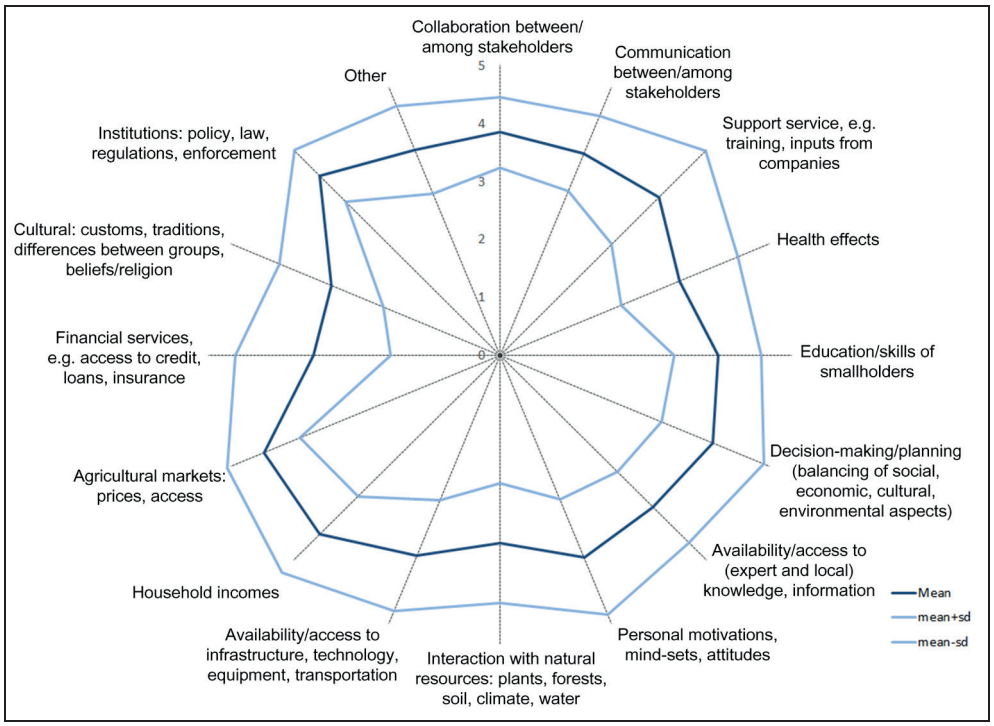
There was general agreement among stakeholders that multiple factors combined to keep rubber cultivation locked into unsustainable practices and that a change towards green rubber would involve addressing an equally wide range of factors. Although the exact scores differed slightly between informants, generally all of them gave high scores to most of the factors – meaning that they considered that the greening rubber topic is totally enmeshed in all manner of dimensions and must be addressed holistically. The average scores of the importance of factors in terms of the need to address them in a sustainability-promoting initiative are presented in Figure 4.3.

Table 4.1: Dimensions and ranges of green rubber at different scale levels as defined by workshop participants

Level of practice	Degrees of sustainability (also relating to the degree of difficulty in achieving sustainability)		
	Light green	**Medium green**	**Dark green**
Plot/farm level	-Reduction of chemical use -Build disease observation and prevention system -Improved soil fertility management, including intercropping that does not enhance erosion -Improved rubber hybrids -Improved farmer awareness about environmental protection -Improved home gardens	-Chemical use halved -Start implementing disease observation and prevention system -Improved soil fertility management, especially undergrowth to reduce run-off erosion -Mixed planting or zoning of rubber and other trees (e.g. fruits, timber) -Positive attitude towards environmental protection starting to lead to behaviour change	-Chemical use down to 20% of original levels -Precise prediction for disease prevention and reduction in chemical use -Integrated soil fertility management -Widespread application of undergrowth, including after closing the canopy -Buffer zones -Farmers' decision making based on principles of environmental protection
Village/ area level	-Improved system to expand literacy -Improving knowledge about production techniques and core values -Open-minded village leadership -Limited understory plantation -Improved village regulations (rubber zoning plan, water resource forest, altitude of planting, steepness of slope, etc.)	-Further improving literacy rates -Further improving knowledge about production techniques and core values -Village leadership's acceptance of vision for green rubber -Expanding understory plantation -Village regulations starting to bear fruit in relation to water source protection and reduced plantation on high elevation/steep slopes	-High-level literacy supports environmental awareness -High-level knowledge about production techniques and core values -Village leadership actively supporting vision for green rubber -Most rubber plantations have at least functional undergrowth (reducing soil erosion) -Village regulations effectively implemented
District/ prefecture level	-Recovery of original zoning plan for rubber in Xishuangbanna -New markets found -Initial compensation for ecological planting -Limited eco-tourism as alternative income -Beautiful Xishuangbanna as general idea -Distinguishing between economic and uneconomic areas for rubber	-Implementation of original zoning plan -Expanding new (incl. niche) markets for alternatives to rubber -Further compensation for ecological planting -Diversification between economic and uneconomic areas for rubber -Eco-tourism as alternative income -Integrated sustainable land use plans -Beautiful Xishuangbanna as an active vision	-Landscape-level diversification with local specialisation (incl. rubber) -Ecological corridors to maintain biodiversity and migration or exchange of species -Integrated sustainable land-use plans being implemented -Beautiful Xishuangbanna as guiding principle in decision making -Corporate social responsibility schemes support green landscape

The scoring shows some variation, but a clear pattern. The factors are an elaboration, translation, and further specification of the nine core dimensions in the PROMIS framework as elaborated in Figure 4.2 for the relevant context of rubber cultivation in Southwest China.

Figure 4.3: Scoring by informants and workshop participants of the perceived significance of change factors to be addressed in scaling up green rubber practice



From the interviews and the workshop, a number of priority issues emerged that need to be addressed.

Firstly, researchers and policymakers need to become much better connected to smallholders in reciprocal ways. Researchers and government agencies are producing knowledge and information, but are not interactively exploring ways forward with smallholders and responding to their specific knowledge needs, and levels of reciprocal trust and respect are low. The resultant malfunctioning system for supporting the scaling of green rubber limits opportunities for change. New patterns of communication, collaboration, and coordination among stakeholders would need to be developed, most notably between experts and smallholders.

Secondly, there is a lack of integrated land-use planning between government departments, but also at village level, where traditional planning systems have been eroded by self-interest springing from potentially lucrative rubber incomes and other

cash crops. This also relates to land-use decisions being primarily motivated by financial-economic incentives and not by environmental or socio-cultural concerns (as they were traditionally). This touches on deeply ingrained patterns (paradigms) that have been institutionalised in practices and processes at all levels and affect all stakeholders. Finally, although there is a clear need for institutional changes, there is also a lack of proven alternative crops or income sources, including a lack of infrastructure for accessing markets and product processing. A major lock-in factor was that the high income enjoyed from rubber makes it hard for farmers to even consider moving into alternative livelihood options, without having firm confidence that incomes will remain high. The possibility of tourism providing alternative income-generating opportunities for smallholders was also raised by a number of respondents. Currently, local people receive a small proportion of total revenues generated from tourism, which could be increased given the correct enabling conditions.

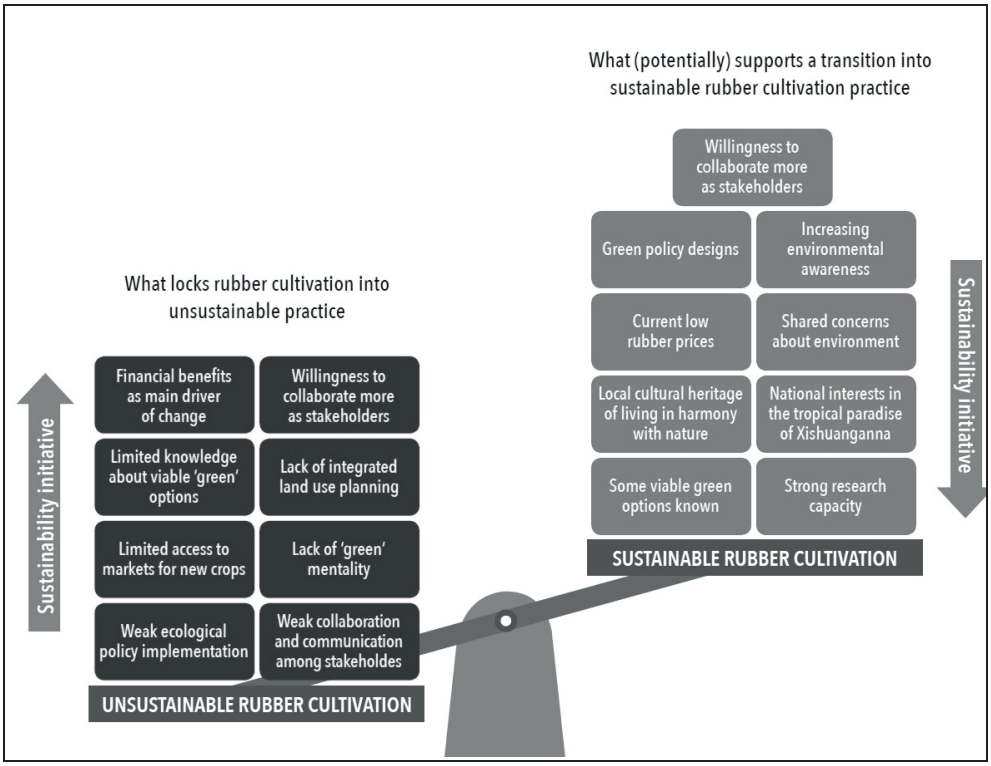
Informants interviewed as well as workshop participants expressed ideas on what could be done to address these issues, ranging from enhancing the availability of, and access to, expert and local (farmers') knowledge, to enhancing green policies and regulations, notably in terms of implementation and enforcement, providing compensation for ecologically sound practices, and enhancing environmental education. Informants did not agree upon one or two factors that would be able to unlock the stalemate in moving towards rubber sector sustainability. Identified responsibilities for decision making and action in relation to the various factors are spread out over actors ranging from government and scientists to companies and individual farmers. This confirms suggestions by Warren-Thomas et al. (2015) that a sustainability-promoting initiative will need to be broad-based, mitigating the effect of lock-in factors and dynamics in the current rubber system, as well as capitalising on factors and dynamics that can potentially unlock opportunities for a transition towards sustainable practice. We present the range of lock-in and enabling factors in the diagram in Figure 4.4. A sustainability-promoting initiative will need to engage with this force field (see Appendix A for more detail).

4.5 Discussion: tackling the challenges to scaling green rubber through facilitated multi-stakeholder interaction in Xishuangbanna

Since the introduction of rubber in the mid-1900s, rubber cultivation has become connected to many aspects of Xishuangbanna society, and, as our results show, changing rubber practices will require more than promoting knowledge about technical solutions. In order to facilitate a transition towards green rubber, many factors would need to be addressed in the scaling of alternative technologies, practices, and policies, all of which could have a knock-on effect on the land-use

system beyond rubber. Hence, as rubber is the major crop in Xishuangbanna, it could be used as an entry point to build necessary capacities among smallholders, villages, and institutions to manage land use sustainably, to develop more resilient incomes, and, perhaps most importantly, to hold reciprocal and meaningful dialogue between the levels (i.e. plot/farm level, village level, and district/prefecture level). This means that issues involved in making a transition to green rubber should not be addressed in isolation, but as part of wider landscape governance (van Noordwijk et al. 2012; Sturgeon et al. 2014), involving landscape-level diversification with local specialisation. A landscape perspective enacted at the district/prefecture level would need to take rubber as one of the (main) forms of land use, considering interactions, trade-offs, and potential synergies in view of other (possible) forms of land use. For example, such a landscape perspective could help prevent an initiative with a focus on sustainable rubber leading to the same problems emerging in an alternative cash crop – for example banana – which would take the place of rubber, with the danger of repeating the cycle of boom and bust with another crop. Many of the lowland valleys are climatically suitable to bananas, and there is a well-developed transport infrastructure. Bananas have already been established widely, and banana plantations are even visible on high and remote hills.

Figure 4.4: Key factors and actors involved in tipping the balance of factors that determine prevalent rubber cultivation towards favouring green rubber cultivation



As deeply ingrained patterns of short-term gains have been the main driver of decision making (see also Figure 4.4), a transition to green rubber is likely to be gradual. This requires the development of complementary short-term (e.g. working with actors and factors that are ready to change), medium-term, and long-term scenarios (Campbell et al. 2015), as well as the development of complementary top-down (such as government policy to limit environmental damage) and bottom-up (such as farmers learning about cropping systems) sustainability-promoting initiatives (Millstone et al. 2015). The perspective developed by local informants during the workshops (Table 4.1) seems to dovetail with these calls from Campbell et al. (2015) and Millstone et al. (2015). However, such a multi-tiered and long-term action plan will require institutional changes supporting, for example, greener mind-sets and more reciprocal relationships between experts and smallholders. Such change involves paradigm shifts in the way that all stakeholders think, act, and interact with one another, and moves beyond the specific crop of rubber, entailing the whole nature of sustainable relationships between humans, their host landscapes, and the supporting ecosystems (Liu and Leiserowitz, 2009). In the transition to sustainable rubber cultivation, the variety of entry points required to relate to the different dimensions distinguished in Figure 4.2 – from finding economic alternatives to developing green mind-sets – need to work in tandem to prevent merely shifting problems to other types of land use.

These kinds of changes cannot be expected to happen spontaneously and need to be facilitated and enabled through interactive processes; this often requires specific support (actors/groups/projects) to take up a specific and focused role to facilitate shared learning spaces and convergence among visions, motivation, and stakeholder efforts (Klerkx et al. 2009). This involves facilitating societal problem-solving in relation to land-use planning (Herrmann & Fox, 2014; Sterk et al. 2011), particularly in addressing trade-offs between economic interests and environmental benefits. The workshop that was part of this research, together with an earlier rural innovation platform initiative in which different stakeholders are working together to enable green rubber scaling (Hammond, 2014), uncovered broad-based agreement among stakeholders that attempts to facilitate the convergence of ideas and efforts were worthwhile, productive, and appreciated. Currently, no single actor has a mandate or the capacity to provide overall strategic guidance to facilitate change. The Xishuangbanna prefecture government in principle has such mandate, but because of its limited capacity to take up such role and poor reciprocal communications between government and villagers, informants thought that their possibilities were limited at this stage. To create sustained societal and policy support for this, multi-stakeholder collaboration will need to be shaped with Chinese characteristics (Grumbine & Xu, 2011; Keping, 2012) while at the same time establishing reciprocal communication and trust between farmers and the experts and political leaders. The recent research for

development platform activities and communications facilitated by the Centre for Mountain Ecosystem Studies and World Agroforestry Centre (CMES/ICRAF) have illustrated what is possible in terms of facilitating stakeholder interactions (Hammond, 2014). For example, they showed that it is possible to convene a wide range of stakeholders with different stakes in rubber cultivation to discuss common concerns and explore opportunities for breaking unsustainable patterns. However, without sustained sponsorship for this multi-stakeholder-support function, this is not likely to continue as it involves interactions for which there are no existing fora in Xishuangbanna.

4.6 Conclusion

In order to promote the scaling of green rubber cultivation, this paper contends that more needs to be done than merely develop standards and introduce new technologies. As Warren-Thomas et al. (2015) concluded, there is a need for robust sustainability initiatives, and we would argue that 'robust' includes the need to develop mechanisms that integrate technical knowledge, enhance social relationships, and present a forum for reconciling – or at least acknowledging – the differing needs, knowledge, and objectives of different groups, and transcending the power dynamics between smallholder farmers and government and researchers. As the paper has shown, applying PROMIS to an integrative analysis with stakeholders sheds light on the different dimensions in which changes need to be made to foster the scaling of green rubber. Opportunities for tipping the balance in favour of green rubber as discussed in this short communication relate to the context of Xishuangbanna, but similar conditions exist in other places in the region. Therefore, the relevance of this case across borders in Southeast Asia concerns in particular two routes of influence: through cross-border (ethnic) connections (Sturgeon, 2013) and through expanding interests of Chinese rubber companies in the Mekong region (Hicks et al. 2009; Smajgl et al. 2015). Therefore, changes for better or worse in Xishuangbanna have the potential to spill over into the wider Mekong region or even more extensively.

Acknowledgements

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valuable comments and suggestions on an earlier version of this short communication.

Appendix A: Summary descriptions of conditions for tipping the balance in favour of green rubber

In the following paragraphs we summarise the more nuanced information obtained during interviews and the workshop regarding conditions relating to the nine described aspects. This overview is based on the full (unpublished) report of the field study.

1. Institutional and cultural conditions

Key informants considered lock-in factors to include the possibility that land tenure will be revoked by the government (at end of assigned period, usually 50 years) and re-allocated, leading to short-term perspectives regarding land management. Furthermore, policies to control environmental impacts are said to be insufficiently implemented or enforced. The tendency to "respect the farmers' opinion" comes after a history of urging farmers to grow rubber. Now leaving farmers to sort things out on their own within an unconducive institutional landscape may inadvertently exacerbate a 'tragedy of the commons' (Hardin, 1968) and rather requires rethinking ecological governance which includes farmers' voices and knowledge (Sturgeon et al. 2014).

Key informants considered change factors to include the fact that the government has moved on from an authoritarian 'command and control' approach, which is a first step towards a more participatory land use planning process (Schillo, 2012), although the mechanisms for dialogue between smallholders and government representatives have not yet developed. There are already a number of policy frameworks relating to the reduction of environmental impact of rubber (e.g. Delang and Yuan, 2015; Liu et al. 2014b). The Chinese government and public want to see a 'greener' Xishuangbanna, since Xishuangbanna is a metaphor for a tropical paradise. The idea of green rubber can be instrumental in this. The government policy of 'beautiful China' (Qiao et al. 2014) and its local version of 'beautiful Xishuangbanna' may provide opportunities for connecting national interests (and funding for eco-friendly experiments) to the pride of local smallholders of being stewards of the cultural and biological richness of Xishuangbanna. This would involve reviving the heritage of cultural traditions regarding living in harmony with the environment (Xu, 2015).

2. Social and organisational conditions

Several key informants reported that traditional forms of social organisation (e.g. village elders/council decision making) are waning, and is symptomatic of a more general sense that community and related cultural values are disappearing. Weak knowledge diffusion mechanisms, weak extension and patchy implementation by government agencies further limit opportunities for change. This also relates to demonstration projects which focus on 'show and tell' and not so much on learning by doing or participatory research. Together with an entrenched social order whereby Han Chinese are the innovators, and local minorities should follow their lead, villagers still find it hard (or possibly risky) to accept their own decision making power.

Key change factors which key informants envisaged relate to people tending to 'follow each other' in terms of practices. Farmers said that if an idea appears economically viable, others will copy it. In this, local champions can be very important, potentially more so than demonstration plots. External (research) groups such as ICRAF (the World Agroforestry Centre) and SURUMER (Sustainable Rubber Cultivation in the Mekong Region) appear to be able to play a key role in facilitating coherence and convergence among stakeholders in Xishuangbanna.

3. Financial-economic and market conditions

Some key informants considered that a transition towards green rubber practices would reduce overall profits for farmers. Stakeholders all agreed that this is a serious disincentive (Mann, 2009). At the same time, markets for new alternative crops (such as medicinal plants) are often uncertain or unstable, and proven alternative value chains are scarce. A further complication is that land renting means that outsiders, who have only recently moved to the villages, are leasing the land of villagers (Tang et al. 2009) with little long term concern for the quality of the land or environmental consciousness (Aenis et al. 2014).

The rubber price crash has been keenly felt by those who rely heavily on rubber profits. So far few have replaced their rubber with different crops, because of high investments made and delayed returns (rubber productivity peaks only after 7 years). With current low prices, it is hardly affordable to harvest rubber and paying labourers is not economical. Even if rubber prices increase again, low prices have exposed the vulnerability of livelihoods which depend solely or largely on rubber, which makes people consider alternative options or diversification more seriously. Those whose rubber has come to the end of the productive life cycle will more easily change cultivation plans. Profits at lower elevation are much greater than at higher elevations. Targeting change at higher elevations seems to be good approach. Closer to cities/tourist hotspots there are more opportunities for alternative income. Tourism may in principle be a good opportunity for alternative income to rubber cultivation, but more equitable, sustainable and culturally sensitive tourism business organisation is required in order for this to become a socially and environmentally positive industry.

4. Conditions of structures, devices and (crop) technologies

Some key informants suggested that earlier success of the introduction of cold-hardy rubber hybrids has turned into a lock-in factor since it helped extend the areas in which rubber can be grown successfully; otherwise there would have been more natural limitations to its spread. New hybrids are expected to lead to even further expansion (Warren-Thomas et al. 2015; Zomer et al. 2014). In terms of alternative crops, farmers do plant high-value (timber) trees here and there, but in very limited ways. Waiting 30 years before a tree provides income is not a strong motivator for farmers. Furthermore, adopting new crops is difficult because of market related risks, and there is no safety net for smallholders in case their crops are not profitable. The jungle rubber model is problematic in Xishuangbanna since it makes harvesting rubber more labour intensive and requires a greater land take.

In terms of opportunities for change, organic tea is becoming more attractive, fetching high to very high prices in the market. For rubber plantations at higher altitude it may become more

attractive to re-establish tea cultivation again. Tea is also strongly associated with regional identity and pride, in a way which rubber is not. Banana plantations have increased in recent years due to high market prices. This can be an alternative to rubber, but has higher environmental impacts and so is not favoured by government or research stakeholders. In general, herbicide and agrochemical use is unnecessarily high and could be reduced by better coordination in villages and by improved knowledge. If use of herbicides can be reduced, understory vegetation recovery would lead to further benefits, most notably erosion control.

5. Conditions of the natural environment and natural resources

Studies on soils under rubber show that they have been strongly affected because of rubber cultivation. After growing rubber for a long time, it is difficult to grow something else on that same plot (de Blécourt et al. 2013). There is a perception that long-term rubber plots lower the water table, meaning that other crops can then not be established without a long fallow period. Local climate change appears to have been influenced by loss of closed canopies in winter when rubber trees shed their leaves. This may be irreversible, particularly if exacerbated by global climate change processes.

Strictly looking at conditions of the natural environment, key informants considered that change factors would relate to people realising how conditions have deteriorated and the need for change. There is now more evidence of erosion, pollution (through biochemicals), local climate change and hydrological depletion. The government is already aware about the serious need for environmental protection. The interview with farmers showed that they are starting to become more aware of this e.g. through incidents such as biochemicals leaking into fishponds and dropping quality of drinking water.

6. Conditions of people's mind-sets and core motivations

Our study confirmed that monoculture rubber is often still equated with 'the modern way' and diversified landscapes with 'the old way', which constrains motivation to go for green rubber. The collapse of traditional rules and decision-making structures has led to individualised decision-making where financial profit is the major motivator, more than e.g. socially responsible behaviour. The older generation is on the one hand attached to cultural traditions and greater biodiversity, but at the same time clearly remember the poverty of their youth and do not wish to return to that state. Smallholders see pollution and erosion but for many the money earned outweighs such impacts. At the same time, scientists and policy makers still tend to think of smallholders as (unwilling) recipients of advanced practices, rather than as co-creators and partners in landscape conservation and restoration.

After decades of practicing monoculture rubber, local farmers have become aware of its negative effects and risks (ecological, economic, social and cultural), therefore ideas regarding a 'return to nature', 'mimicking nature' and the concept of 'green rubber' does speak to their core motivations. The potential for change may also relate to environmental protection increasingly becoming a hot topic in urban China and becoming more so in rural China. The younger generation grew up with improved livelihoods and a modern life style, but tends to also be more conscious about environmental impact. New generation local ethnic leaders can be champions

of change. Also, the sense of self-sufficiency (food) and traditional (ecological) worldviews may be reinvigorated, e.g. through documentaries, NGO-work and the example of village leaders. Media paying more attention to negative environmental effects of rubber on Xishuangbanna, may also motivate change, connecting people's local experiences to wider interpretations of what is happening across the region.

7. Conditions of knowledge, information and approaches

Most key informants agreed that in the end, farmers want 'proven' solutions which can compete with the income from rubber. However, full proof is difficult to give and there will always be some level of risk involved. Expertise in rubber farming and use of agro chemicals is considered to lie outside the field of traditional smallholder knowledge. Communication products such as brochures, newspaper articles, and tv coverage are available to showcase opportunities for improvements, but these seem to be rather disconnected from the world of smallholders. This also relates to the fact that scientists and government agencies often tend to be technically-oriented, seeking solutions through the introduction of new "winner" crops and through suggested new practices such as multi/intercropping. Only few approach the situation from an integrative social, technical, economic and cultural perspective.

Opportunities for change may relate to e.g. home gardens, fruits, vegetables and tea production being within sphere of traditional knowledge, local pride and people can grow those crops without chemicals. There are still some good examples of villages in Xishuangbanna which show a balanced landscape management model. This model may be revived and promoted as an inspiration for others. Furthermore, rubber companies are more up to date with the latest technologies and practices as they have to follow government guidelines on new practices. Knowledge can spread from companies to smallholders; indeed this is how most smallholders learned to cultivate rubber initially. Finally, there is an extension infrastructure and capacity which may be upgraded and aligned to more of a participatory and co-innovation approach to unlock a potential for collaborative action.

8. Conditions of health, education, skills

Many smallholders lack skills and knowledge to manage rubber plantation in environmentally friendly ways resulting in suboptimal production and inappropriate use of chemicals. Alternative crops often involve different labour and skills requirements, which makes farmers hesitant. Vocational training does not connect well to farming practice; children who go for education often do not return to farming. Shorter trainings are needed which better connect to smallholder conditions, seasonal activities and are more practical in nature. This also relates to the need for new competencies of researchers to play more flexible roles in the agro-ecological innovation system (Wittmayer and Schäpke, 2014).

Opportunities for change may be found in strong local research capacities, existing modes of extension which can be improved toward more collaborative approaches, involving smallholders who are 'experience experts' regarding environmental and cultural conditions. Health concerns have so far not been serious, but are starting to be noticed; e.g. people don't eat the same vegetables as they sell in the market, and many water sources are now considered

unsafe. Environmental education of youth is a long term solution, which has already begun at small scale through efforts by e.g. the Xishuangbanna Tropical Botanical Gardens, but is by no means widespread.

9. Conditions of visions and planning for the future

Our study concluded that responsibility for integrated landscape planning in the government is diffuse with no clear central coordinating unit and many agencies involved, but not necessarily working in same direction. Different groups and organisations have different ideas about what needs to change, which tends to lead to piecemeal engineering while a serious change in the direction of green rubber would require a common vision and concerted efforts.

Planning used to be centralised and top-down. Now that it is more decentralised, farmers are allowed to decide many things for themselves, creating opportunities for change. Support mechanisms for informed farmer decision making have not yet been established, which would need to be worked on. Combined with change factors described in the above, this may support farmers in becoming more assertive and take responsibility as stewards of the landscape.

Chapter 5

Scaling and institutionalisation within agricultural innovation systems:

The case of cocoa farmer field schools in Cameroon

5

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5.1 Introduction

The farmer field school (FFS) concept and such schools' positive impact on agricultural development and wider societal benefits (e.g. poverty alleviation) have been studied by many scholars (e.g. van den Berg & Jiggins, 2007; Feder et al. 2004; Friis-Hansen & Duveskog, 2012; Davis et al. 2012; Larsen & Lilleør, 2014; Phillips et al. 2014; Tripp et al. 2005; Yorobe et al. 2011). Waddington et al. (2014) report FFS as one of the most common approaches to rural adult education and agricultural extension involving 10–20 million people in more than 90 countries. This means that use of the FFS approach has scaled up significantly since its emergence in the 1980s, although the nature and quality of its application may vary (Sherwood, Schut, & Leeuwis, 2012). Neither individual studies nor comprehensive reviews such as that conducted by Waddington et al. (2014) address systematically what is involved in processes of scaling-up the application of the FFS approach so that it becomes an integral part of agricultural innovation systems. The focus is generally on what the FFS is about and what it effects are. Although in numbers FFS has evidently gone to scale, questions remain regarding what is involved in the success and failure of purposefully attempting to scale it up and institutionalise it in agricultural extension systems.

We were particularly confronted with this question when assessing the Sustainable Tree Crops Programme (STCP). This public–private partnership (PPP) initially focused on designing, testing, and validating an innovative cocoa FFS curriculum – designed to augment cocoa farmers' income by sustainably increasing the yield and quality of their crops – and in a next phase set out to take the approach to scale. STCP was the first large PPP focusing on scaling agricultural innovations for cocoa in sub-Saharan Africa (David, 2007, 2011; Gockowski et al. 2011). The programme was implemented in Cameroon, Côte d'Ivoire, Ghana, and Nigeria (and to a lesser extent in Liberia) between 2001 and 2011. Although in each country except Liberia FFS was introduced in virtually the same manner and with similar staffing, the scaling-up processes led to significantly different results (Muilerman et al. 2017). In Cameroon, a country with stable leadership and a stable institutional landscape for cocoa, FFS went to scale in terms of numbers of schools but in fact spread to only a dozen emerging cocoa cooperatives. By 2011, the programme had trained virtually all the members of these relatively small cooperatives, often including recruited non-members. During an internal regional STCP management meeting in early 2011 (first author's notes), the regional management assessed that the focus on a limited number of cooperatives with limited membership would not enable FFS scaling. Impact was not significant, there were important quality concerns, and the sustained adoption of cocoa FFS in the national innovation system in Cameroon was deemed highly unlikely. Nor was there clear proof of adoption of core FFS principles by government or by national NGOs. This analysis was corroborated by interviews with government officials in July 2010.

Côte d'Ivoire, a war-torn country in crisis, managed to take FFS to scale through institutionalisation in the national professional extension services (Muilerman & Vellema, 2016). A general retrospective, a comparative analysis of what happened in the four STCP countries, provided several clues regarding differences in the extent to which, and the reason why, scaling did – or did not – occur in Cameroon, Côte d'Ivoire, Ghana, and Nigeria (Muilerman et al. 2017). This general comparison showed that in Cameroon (contrary to particularly Côte d'Ivoire and Nigeria) STCP faced a more challenging institutional context. The programme experienced decidedly less favourable interactions with the national agricultural institutions. A lack of involvement with the dominant national cocoa system meant that virtually no room was made for the FFS innovation, and this contributed to FFS never leaving its protected niche environment. The analysis indicated that the necessary preconditions for the scaling of FFS were simply not present, nor evolving in the right direction. However, the case of scaling cocoa FFS in Cameroon remained substantially more ambiguous and more difficult to interpret in terms of the specific mechanisms and factors that led to the limited level of scaling and the failure to institutionalise FFS.

Here, we propose to analyse the Cameroon case in more depth, using an analytical framework that has the potential of helping to uncover a broad range of potential factors and dynamics that may have played a role in impeding the scaling of cocoa FFS and in the failure to institutionalise it in the agricultural innovation system. This may also provide relevant insights for scaling similar participatory approaches and multi-stakeholder processes, such as innovation platforms and innovation labs (e.g. Kilelu et al. 2013). Going to scale is an important theme in the FFS literature. Discussions in STCP focused on approaches to scaling, changes to the methodology in the course of expansion (Schut & Sherwood, 2007), and modalities for ensuring financial sustainability (Feder et al. 2008). Investing in an intervention is a key element for reaching scale, especially if a donor-funded extension-led FFS is to be followed by sector-funded and/or community-led initiatives (Settle et al. 1998), although this idealistic model of fiscal sustainability has been strongly criticised (Feder et al. 2008). Worldwide, the combined start-up and recurrent FFS costs are highly variable, ranging between US$ 10 and 80 per participant for FFS on food crops (van den Berg & Jiggins, 2007; Duveskog, per. comm., 2011), with cost depending also on the type and scope of the implementing organisation and the length of the training.

This study builds on findings from earlier impact studies that focused on the programme (e.g. David, 2011). The PROMIS methodological approach (Wigboldus et al. 2016, 2017) was selected because of its suitability for understanding a range of dimensions and dynamics involved in scaling processes (see section 3). This choice is in line with findings by van de Fliert et al. (2010) who emphasised the need for a systems perspective when introducing innovations. PROMIS builds on the multilevel

perspective (MLP) on socio-technical innovation (Geels, 2002) and the theory of modal aspects (e.g. Brandon & Lombardi, 2010), enabling the development of integrative, analytical, and strategic perspectives on scaling initiatives. Selecting key elements from this approach, we developed a conceptual framework that matches the needs of this study, which sets out to answer three main research questions:

1. What factors and dynamics provide the best explanation for the failure to achieve scaling and institutionalisation in the case of STCP and cocoa FFS in Cameroon?
2. To what extent does the broad analysis as applied in this study provide additional insights that lead to a deeper understanding of factors and dynamics involved in scaling and institutionalising FFS?
3. What wider lessons can we learn from this case for the design and implementation of future scaling initiatives?

Section 2 briefly describes the relevant context. Section 3 elaborates on the conceptual framework and methodology used in this study, using illustrations from section 2 to clarify this paper's orientation. Section 4 provides a narrative account of the findings, and section 5 provides an analytical account of the findings. These two research angles are then further discussed in section 6, which revisits the three research questions, discusses possibilities for the wider application of the findings, and presents conclusions from this study.

5.2 Context and background to the case

5.2.1 History and environment of the cocoa sector

Cocoa was introduced into Cameroon as early as 1890 (Monga, 1996). Agriculture contributes to nearly a quarter of Cameroon's GDP (World Bank, 2015) and is the main source of employment (UNdata, 2015). Reportedly, 600,000 smallholder farmers produce cocoa. FAO data (FAOSTAT, 2015) show that, at the onset of STCP, cocoa productivity was low (~375 kg/ha). The STCP baseline on Cameroon (IITA/ODECO, 2003) attributed this mainly to an aging tree stock (av. 32 years; 2 years over what is considered the maximum optimal productive age), high farmer age (av. 50 years), and widespread prevalence of pests and diseases. Most cocoa smallholders grow their own food, but cocoa sales constitute their primary source of revenue. The STCP baseline also showed that 24% of cocoa farmers were members of some formal rural organisation and that 35% had had contact with governmental extension workers in the previous three months (IITA/ODECO, 2003). Although Cameroon was better serviced by governmental extension in 2001, as compared to major cocoa producers Côte d'Ivoire (31%) and Ghana (23%) (Kouadjo et al. 2002; IITA/KNUST, 2003), extension focused primarily on larger farmers. International multinationals became

increasingly worried about this situation. A dozen years later, Cameroon's production of over a quarter of a million tonnes of cocoa continued to be based on the use of vast areas of land, not on intensification. Smallholder households continued to obtain low yields (~400 kg/ha) (FAOSTAT, 2015) on hundreds of thousands of relatively small plots.

5.2.2 Cocoa extension and innovation system in Cameroon

In this paper, we focus in the agricultural extension institutions for cocoa in Cameroon. Private and NGO extension was practically non-existent. Previously, cocoa farmers could call upon specialised cocoa extension agents from the Cocoa Development Corporation. However, even though the government of Cameroon was sluggish in adopting reforms, in the 1980s and 1990s liberalisation and various IMF and World Bank programmes, including structural adjustment programmes, progressively put an end to large state and parastatal extension services (IITA/ODECO, 2003). For many years, MINADER (*le Ministère de l'Agriculture et du Développement Rural*: Ministry of Agriculture and Rural Development) in Cameroon had been running World Bank-promoted Training & Visit (T&V) programmes. Each of its extension agents focused on multiple crops. From 2002 onwards, MINADER adopted a single crop focus. All of this transpired during the presidency of Paul Biya, which was characterised by a socio-political status quo (Ngwafu, 2014). In 2010, President Biya, having already served for 29 years, was re-elected in 2010 'against a background of general indifference'; and the IMF reported that same year: 'although [Cameroon] has plentiful resources, its economic results do not match its economic potential because of the government's reluctance to adopt reforms' (Pigeaud, 2011: 1).

By 2010, MINADER's PNVRA (*Programme National de Vulgarisation et de Recherche Agricoles*: National Programme for Agricultural Extension and Research) still had the mandate for agricultural extension, including for cocoa. Interview data suggest that the technical modules on integrated crop and pest management and good agricultural practices that featured in FFS were in themselves considered to be very valuable and could perhaps have been integrated into PNVRA's programmes if they had not been treated as part of a fixed package. As a result, although MINADER and IRAD (*Institut de Recherche Agricole pour le Developpement*: Institute for Agricultural Research for Development) contributed to the technical curriculum, MINADER/PNVRA did not feel that it had specific ownership of the FFS approach. The STCP/FFS programme included a number of principles and components (sections 3 and 4), but Cameroonian enthusiasm for FFS outside partner cooperatives related not so much to FFS as process principles, but rather to the technical curriculum and what quality training could do for farmers (i.e. responsible use of chemicals, social organisation, enhanced profitability). The inflexible FFS approach came with package deals such as the

reduction of pesticide use. A conflict of interest therefore arose as MINADER was promoting pesticide use. The lack of flexibility in applying the FFS concept meant that STCP did not focus on the purpose behind FFS – a purpose that might have been achieved in other ways as well (e.g. innovation platforms or other forms of participatory [technology] development).

A new development in 2006 was the inception of the National Cocoa and Coffee Sub Sector Development Fund (FODECC), a national fund based on export levies, which in a complex configuration was to be managed collaboratively by three different ministries. FODECC struggled to become operational and by 2010 was yet to develop into a more serious financier of cocoa extension. The STCP country manager reported that STCP never made a functional connection with FODECC and therefore did not manage to secure national funding for FFS.

5.2.3 The STCP Cocoa FFS initiative

In the 1999 Paris Declaration, the chocolate industry, donor agencies, trade organisations, producer groups, and major research institutions made a commitment to sustainable cocoa production. In 2000, STCP – worth US$ 8 million (Velarde & Tomich, 2006) – was set up as a broad PPP platform to address farmer and business support services, research and technology transfer, policy change and implementation, and market and information systems. It adopted a focus to 'identify, test, and validate innovations in tree crop systems that could serve to guide future development investments in tree crop sectors' (STCP, 2006: ii). In a typical West-African context of weak public and private agricultural extension systems and inadequate training approaches, a pilot was conducted in Cameroon, Côte d'Ivoire, Ghana, and Nigeria (David, 2007). Funded mainly by the global chocolate industry, represented by the World Cocoa Foundation (WCF), and by the United States Agency for International Development, the programme was hosted by the International Institute of Tropical Agriculture (IITA). This is an agricultural research institute with a mandate to conduct research to support development initiatives, although not necessarily to implement development activities on a large scale. STCP's organisational structure consisted of a regional team of a programme manager and technical experts and country teams consisting of a country manager and technical field staff (Velarde & Tomich, 2006). Programme direction was largely decided at country level. The regional staff focused on developing methodologies, technical backstopping, monitoring and evaluation, and scientific production.The cocoa FFS programme in Cameroon needs, therefore, to be considered as part of a larger regional STCP. STCP Cameroon's connection to the wider regional programme is visualised in Figure 5.1. It shows that STCP Cameroon was an entity largely operating independently, having a less than optimal connection with public and private

partners, directly intervening in cooperatives. However, as it operated under a regional PPP programme, the four different country management teams met at least twice a year during the programme's Executive Committee meetings, where experiences were shared and discussed and cross-fertilisation was expected to take place. Participatory observation during several of these bi-annual meetings, however, found that these could not be characterised as (academic) critical spaces, but rather as classic implementer–donor reporting.

Figure 5.1: Simplified overview of flow of decisions from regional to local for STCP Cameroon and its key partners with regard to service provision to cocoa farmer and (the scaling of) FFS.

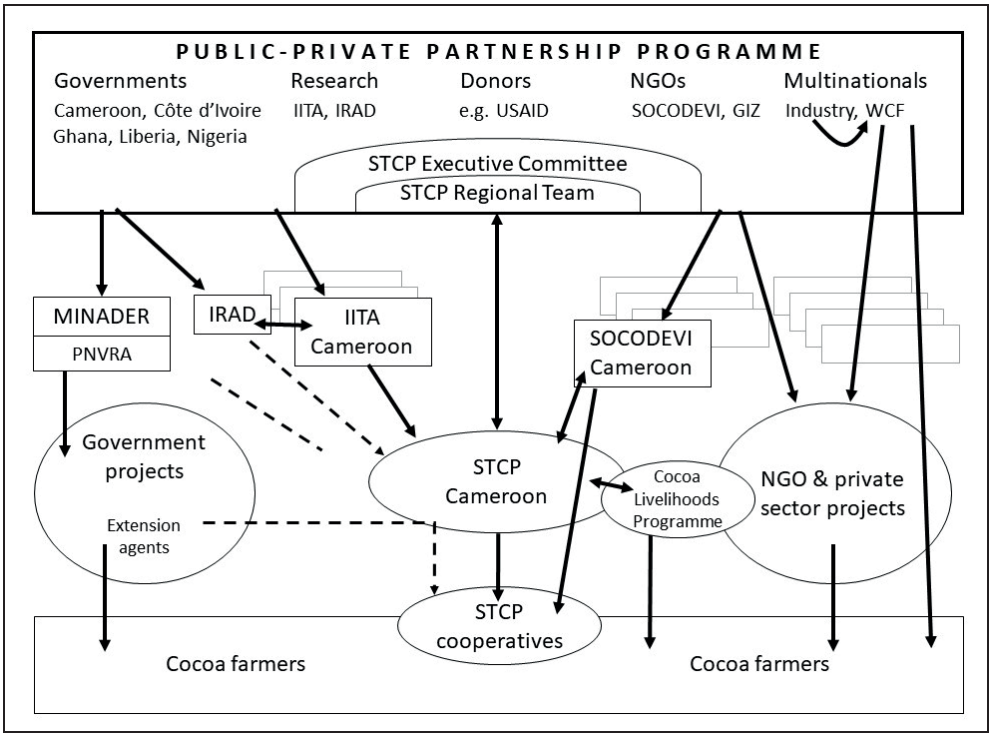


Figure 5.2 presents the type of organisation(s) driving the scaling phase in each country after the initial research-led pilot phases (2001–2005) and how Cameroon remained primarily research-led (percentages are used because the otherwise similar country programmes differed in size). During the STCP scaling phase, the same PPP under WCF leadership started the Cocoa Livelihoods Programme, similar to STCP and initially also implemented by IITA but later by WCF itself.

5.2.4 STCP's cocoa Farmer Field Schools and their attributes

Farmer field schools were designed and first implemented by the FAO in the late 1980s, as a participatory and experimental learning approach focusing on integrated

pest management and food crops in Asia (Simpson & Owens, 2002), rapidly expanding to multiple crops and geographies. After some FFS success with cocoa in Asia (Mangan & Mangan, 2003), FFSs for the perennial crop cocoa in West Africa were set up only in a small pilot in Ghana (Asare, 2005) before STCP and national experts adapted, tested, and validated cocoa FFS between 2003 and 2005 for use on a wide range of topics (STCP, 2003) (Asare & David, 2011; STCP, 2004). The approach constituted a considerable break from the norm because of the altogether different nature of extension provision and underlying principles, as presented in Table 5.1

Figure 5.2: FFS leadership by country and by programme type during STCP scaling phase (2006–2011), based on STCP annual reports.

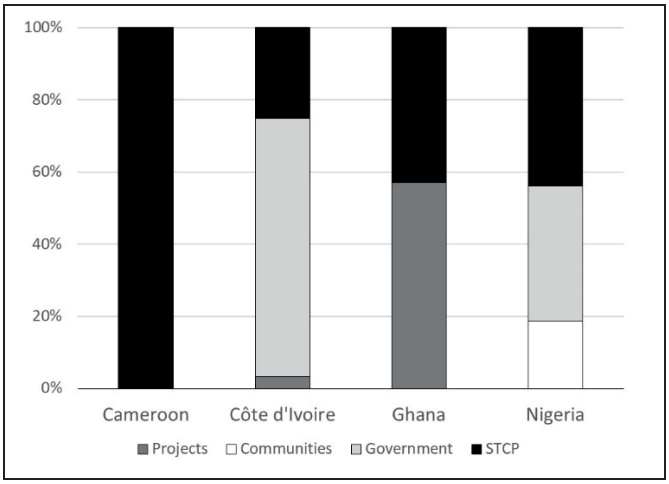


Table 5.1: Underlying principles of STCP's cocoa farmer field schools (based on David, 2004; Schut & Sherwood, 2007)

Principles of farmer field schools
• Adult education that acknowledges experience
• Interactive self-help group training approach
• Focus on field-based and concrete experimental learning
• Trained and competent farmer facilitators
• Practical curriculum based on natural (crop) cycle and emerging issues
• Quality programme management and monitoring and evaluation
• Sustainable financing

In 2005, recommendations from an external review (STCP, 2005a, 2005b) of STCP activities identified FFS, among other things, as a key innovation to be scaled in collaboration with national partners. The STCP PPP itself had been identified as an important innovation 'from which all stakeholders derive value. This unique partnership has never existed for the cocoa sector, which is the most important tree-based commodity in West Africa' (STCP, 2005a, p. 1). The programme's second phase focused on three desirable scaling outcomes: (i) increased numbers of FFS organised in line with the key principles, (ii) increased applications of the principles underpinning FFS in (local) cocoa innovation systems, and (iii) increased use of a cocoa FFS curriculum (STCP, 2006, p. iv).

5.3 Conceptual framework and methodology

In this section, we explain the conceptual framework and methodology used for retrospective analysis of STCP's FFS scaling initiative in Cameroon to ascertain why it did not achieve the desired results.

5.3.1 Conceptual framework used in the analysis

Innovations are embedded in broader societal processes that influence – and simultaneously are influenced by – scaling processes. To better understand how the scaling-up of FFS in Cameroon unfolded and what factors and dynamics were at play, we chose to apply and test an analytical approach specifically designed to analyse and interpret scaling processes (Wigboldus et al. 2016). Called the PRactice-Oriented Multi-level perspective on Innovation and Scaling (PROMIS), it can be used to enhance learning from, and planning for, scaling initiatives. PROMIS involves two main methodological elements: the MLP (Geels, 2002) and the theory of modal aspects (e.g. Brandon & Lombardi, 2011). The first element is particularly useful for making sense of dynamics in innovation and scaling, and the second helps to unpack the multifaceted nature of innovation and scaling.

The MLP is particularly useful for 'reading' and interpreting the unfolding FFS scaling process in Cameroon. Geels (2011, p. 26) describes the MLP as 'a middle-range theory that conceptualizes general dynamic patterns in socio-technical transitions.' Within the MLP, three analytical levels are used to describe non-linear processes and interrelated developments. At the lowest level, we find (i) innovation niches or protected spaces. These may eventually challenge (ii) the stable socio-technical regime(s) with their established rules and practices. A (iii) socio-technological landscape (the wider context) influences both these levels. Niche and landscape influence, and are influenced by, the regime level, which involves constant interactive alignment, adjustment, and reconfiguration of processes. MLP has been used to analyse the scaling of participatory extension approaches before (e.g. Minh et al. 2016). Figure 5.3 is a simplified way of expressing, within an MLP, what the FFS scaling processes were aiming to do in Cameroon.

It is particularly in the interactions between the niche and the regime, during reconfiguration processes, that we expect PROMIS to be able to help further unpack and interpret context and process dynamics at play in scaling processes. As already stated, PROMIS uses the theory of modal aspects, which comprises an ordered collection of 15 modal aspects of experienced reality (Table 5.2). Innovation and change processes are considered to involve a reconfiguration of these different aspects (e.g. Leeuwis, 2013). Scaling processes involve a multitude of such reconfiguration processes as they take place in a variety of specific contexts. This relates directly to,

and expands, MLP dimensions such as industry, markets, and science, which characterise innovation systems in socio-technological regimes (see Figure 5.3). A niche, a regime, and a landscape level can be characterised along the lines of those same aspects of experienced reality. 'Experienced reality' is not about this or that person's way of experiencing reality; rather, it a term that refers to a general concept of reality as it can be experienced.

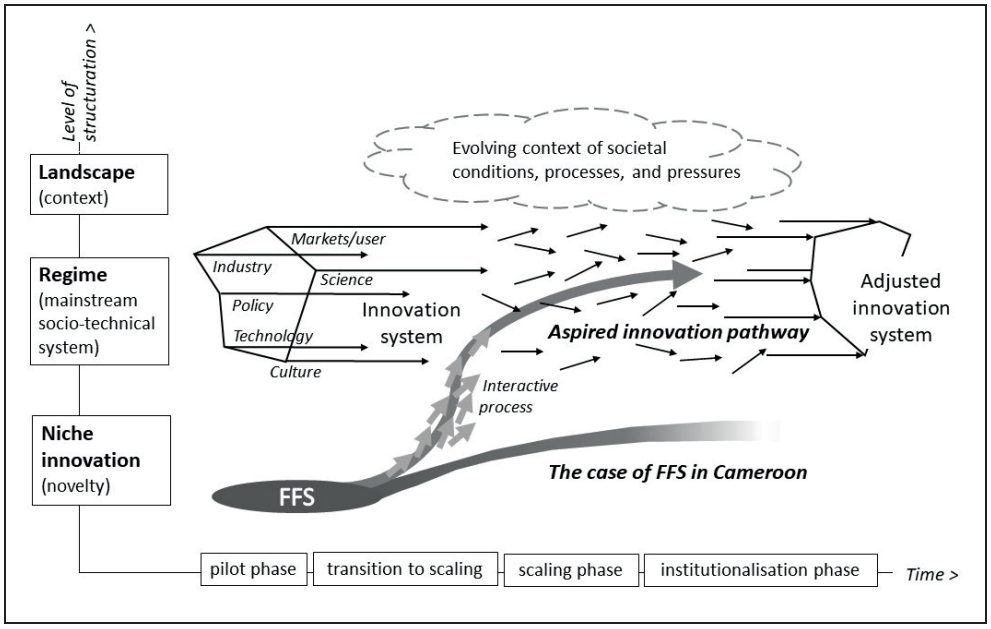
Table 5.2: Aspects of experienced reality that can in various ways be affected by, or affect, innovation and scaling processes (adapted and abbreviated from Wigboldus et al. 2016)

Aspects of experienced reality	**What the aspects typically relate to**
Natural and physical aspects	
Quantitative, spatial, kinematic, physical	Numbers, location, atmosphere, climate, water, soil, natural forces, chemistry, transportation, infrastructure, buildings, equipment
Biotic, sensitive	Plants, animals, birds, fish, organic processes, ecosystem, biodiversity, forest, desert, habitat, farm, crops, livestock, animal behaviour
Human aspects	
Biotic, sensitive	Awareness, health, physical and mental abilities, emotion, personality, disposition, passion, observation, population dynamics, safety
Analytical–logical	Knowledge, theory, logic, conceptual framework, science, research, education
Formative	Construction, creativity, skill, computer software, design, power (in relationship): technology, strategy, methodology, innovation, adaptation
Social and financial aspects	
Lingual, Social	Symbols, signs, language, communication, information, media Relationships, roles, social cohesion, competition, collaboration, organisation, societies, alliances, partnerships
Economic	Resource management, conservation, stewardship, exchange of goods and services, transactions, efficiency, sustainability, economy, land use, market, value chain, firm, employment
Cultural, political, and moral aspects	
Juridical	Rights, law, responsibility, appropriateness, policy, legal system, constitution, mandate, police, the state, democracy, ownership
Aesthetic, ethical, certitudinal	Appeal, beauty, enjoyment, leisure, sports, art Attitude, care, sharing, goodwill, integrity, equity, being right, solidarity identity, belief, trust, faith, vision, commitment, aspiration, worldview, ideology, paradigm

Together, the MLP and the theory of modal aspects provide a rich framework for analysing both the processes involved in scaling initiatives and the *dynamics* of how these play out between the niche and the regime level. The PROMIS approach further identifies 13 types of such dynamics related to what may hinder and what may help an

envisaged scaling process. For the purpose of this paper, we have translated general categories from PROMIS into a set of four simplified analytical categories (Table 5.3): (i) social dynamics (interpersonal and group interactions), (ii) system dynamics (interrelationships and interconnections between system dimensions within the cocoa innovation system in Cameroon and related emerging outcomes), (iii) scale dynamics (how social and system dynamics play out at different scale levels, including the temporal scale), and (iv) management dynamics (managerial arrangements, including roles and responsibilities and related capacities and competencies for task achievement).

Figure 5.3: Application of a simplified MLP to the case of cocoa FFS in Cameroon (based on Geels, 2002; Geels & Schot, 2007)



5.3.2 Method of data collection and analysis

Field research was performed between 2010 and 2011, towards the end of STCP, by researchers not previously connected with the programme. The process tracing method was used for retrospective analysis involving both narrative and analytical categories. Qualitative research, using semi-structured interview guides, was performed, targeting key process actors in Cameroon. A total of 16 in-depth interviews were held in English, French, or a local language (assisted by a translator) with 12 different persons or farmers' groups from STCP, programme partners, and four

partner cooperatives. All interviews were recorded and transcribed. In addition, STCP's extensive electronic and paper archive[21] was reviewed.

STCP did not continue, leaving the data unused. This study takes up the exercise again as an ex-post study.

The following two sections present two different and complementary accounts of our findings. In section 4, we present a narrative account that allows for developing a perspective on how things evolved over time. In section 5, we present an analytical account, applying the analytical categories as described in Table 5.3. The discussion (section 6) synthesises findings from the two research angles, including a discussion of findings along the MLP lines as visualised in Figure 5.3.

Table 5.3: Analytical categories derived from the PROMIS approach (abbreviated and adapted from Wigboldus et al. 2016)

Analytical categories	Description
Social dynamics	Stakeholder decision-making dynamics Stakeholder diversity and social impact
System dynamics	Complexity of scaling Dominance/deviance dynamics System/practice inertia System/practice instability
Scale dynamics	Path dependence and past imprinting Anticipated futures Cross-scale, cross-domain dynamics
Management dynamics	The process of engaging stakeholders The scope of analysis and evaluation, and preparation/anticipation The connection between strategy and situational reality The capacity to facilitate convergence

5.4 Narrative account of findings and their interpretation: Evolution of the scaling initiative

In this section, we examine the STCP chronology, building on the research data and background on the landscape, dominant extension regime, and the niche intervention, as presented in section 2.

5.4.1 Phase One: Introduction of FFS and the pilot process

Interview data and interviews show that STCP's pilot at first focused on a partnership with a vast loosely organised farmer-based organisational network, FORCE. By 1996, FORCE had emerged through a merger of 25 associations, combining 300 farmer groups or 20,000 farmers (FAO, 2002). Although it aligned with the national policy

[21] This included among other things: baseline report; pilot report; transition report; summary external impact review; the monitoring, financial, and training databases; 5 years of annual and semi-annual reports, work plans, budgets and results frameworks, and country summary reports for the scaling phase; 15 relevant studies or working papers; 9 impact briefs/reports; 30 newsletters; 22 collaboration agreements, 7 training manuals, 31 miscellaneous project documents, and 3 speeches by cooperative leaders.

direction to support micro projects, the pilot did not involve MINADER/PNVRA or any other national cocoa institution (except for resource persons from IRAD). This pragmatic choice was based on achieving optimal pilot quality, not on an analysis of necessary capacity among prospective partners for running or scaling FFS later on. The choice to pay FFS farmer facilitators during the pilot served the same purpose. A few MINADER extension agents became facilitators, but only because they had a pre-existing and constructive training relationship with a specific cooperative. A general agreement was signed in 2000 and 2002 (MINADER, 2009), but this service agreement did not focus on building an institutional relationship with the objective of later scaling-up nationwide.

The pilot employed mainly externally hired expert staff. According to the country manager, the initial objective was to organise a high quality pilot, not to influence the existing socio-technical regime or to get national acceptance of the principles underpinning the FFS approach. From the interviews, it is clear that MINADER demonstrated a keen interest in the quality of technical training under FFS, but the approach was not felt to connect with a pressing need for innovation within existing extension practice. Because STCP marketed FFS as the sole methodology to accompany the curriculum, in interviews senior MINADER officials called STCP dogmatic.

5.4.2 Phase Two: The transition process from pilot to scaling-up

The FFS pilot ran roughly from 2002 to 2005, after which an external review of the regional STCP programme (STCP, 2005a) advised the scaling-up of FFS. When the pilot ended and conflict arose with the farmer network, IITA and the expatriate programme manager felt that the idea of a representative network of farmer-based organisations as principal partner had been implemented prematurely. IITA took over full management. When funding was relatively easily granted by the United States Department of Agriculture, the focus was put on working directly with a dozen (emerging) cooperatives, sustainably strengthening their capacities and scaling FFS among the membership.

This meant investing considerable resources in slow, small-scale, local processes. National management pointed out that the United States Department of Agriculture's funding was 'so rigid that farmers had no voice. But [cooperatives] were benefiting from the STCP activities. [Therefore] we just continued.' The country manager confirmed: 'Yes, people are saying they are our baby,' although he disagreed. This approach resulted almost automatically from STCP's close partnership with the Canadian NGO Société de Coopération pour le Développement International (SOCODEVI), which had the objective of building cooperatives and establishing

independent cooperative service provision. The SOCODEVI management confirmed this restricted vision: 'When I die I hope to leave at least two or three cooperatives behind that at least are not so clumsy.' This decision may have closed scaling pathway opportunities later on.

A lack of true partnership – a result of different orientations, different expectations, and a lack of shared effort – in effect meant that the STCP/FFS in this programme was not in partnership with MINADER/PNVRA. The data suggest that the extension system (dominant regime) was not ready to embrace FFS seriously, though possibly it might have accepted the curriculum. FFS was introduced perhaps to supply a rigid extension tool rather than to involve an institutional innovation in any meaningful way.

5.4.3 Phase Three: Management and guidance of scaling process

During this scaling phase, STCP organised a high quality FFS programme (Velarde & Tomich, 2006). However, STCP's scaling strategy (or lack thereof) certainly was criticised. The resolute belief in cooperatives did not result in the desired level of buy-in from the dominant regime. Managing the scale-up alone was a logistical challenge, especially when external master trainers left, resulting, among other things, in a failure to monitor and evaluate, despite heavy research involvement.

By 2010, five cooperatives had dropped out and three new cooperatives had joined, and several cooperative members voiced their concerns about training pressure. Targeted training numbers (scaling) were finally obtained through a questionable tripling of training numbers through farmer-to-farmer training (one trainee transferring knowledge to two non-trainees). The country manager was hesitant about reporting this to the donors. Interviews show diverging perspectives on what scaling FFS would involve.

MINADER agents started to co-facilitate, supervise, and monitor FFS on an expensive consultancy basis, and in competition with other initiatives. Under private sector influence (key donors), this increasingly also happened in 'unstructured' communities, resulting in low participation. This case is therefore not about success or failure of scaling-up FFS in general, but rather about scaling-up the STCP-type of cocoa FFS in Cameroon. It was clear that MINADER/PNVRA could never support FFS. It could not even sustain old-school T&V. The rigid donor-driven framework for implementation in effect reduced farmers to beneficiaries, undermining the whole FFS ideology. FFS was increasingly reduced to a tool for scaling-up the adoption of a technology, and not primarily for addressing farmers' participation. The emerging outcome contradicted the country manager's original objective. The participatory

process of setting up sustainable farmer-led FFS programmes within cooperatives was finally not reflected in the partnership and scaling-up processes.

Table 5.4 outlines the direct cost of FFS, taking into account that an FFS facilitator in STCP Cameroon performed on average three training cycles. STCP Cameroon incurred a direct cost of US$ 84 per farmer trained. Low participation numbers, resulting from working only with cooperative members (on average 20), meant that the cost could have been US$ 56 at an optimal participation of 30.

Table 5.4: Farmer field school cost per farmer

Item	Amount in US$
Start-up: Training of trainers for one facilitator*: *Resource persons; training venue and equipment, facilitators and trainers; food, accommodation, and expenses; per diems and stipends; materials and stationary; transportation*	291
Recurring: Implementation per farmer field school**: *Materials, supervision, facilitator*	1385
Cost per farmer in Cameroon under STCP*** *Training of trainer + implementation cost.*	84

* Assumes that the programme starts with new facilitators, trained and supervised during the first training cycle, who run two more cycles as experienced facilitators.

** Assumes a 20% cost reduction for supervision costs during the second and third years.

*** Based on average recorded participation of 20, although the target for FFS is 30. Includes the costs borne by the cooperatives.

Muilerman and David (2011) outline several options to reduce STCP's implementation cost for public and private sector operators interested in taking cocoa FFS further to scale, including more training cycles per facilitator, bulk procurement of materials, and farmer contributions. Arguments to justify the relatively high cost of FFS include the long-term sustainable impact of improved decision making, the benefits of strengthening human and social capital, and the ability to use FFS facilitators' skills for other development initiatives. FFS costs must therefore be rated against both immediate and long-term development goals.

5.4.4 Phase Four: Institutionalisation and phase-out

Research data do not support STCP's claim in reports that it pursued a two-pronged approach with cooperatives and MINADER/PNVRA. STCP shied away from a structured relationship with the national extension service and never managed to transfer non-training tasks such as monitoring and evaluation to the 20–30 MINADER agents with whom it had worked. In 2010, STCP had lost contact with nearly all of them.

Research data gave reason to doubt the management's belief in, and commitment to, the chosen approach towards the end, but, with mounting donor pressure on the programme, giving up on it was not an option. This led to the over-pressuring of cooperatives that had reached their training limits and to a continued discourse that MINADER would still come on board through a ripple effect.

MINADER, on the contrary, carefully considered the consequences of adopting FFS. Rather than aiming for the rapid scale-up of novelties, MINADER/PNVRA considered the lack of resources and the absence of a clear political decision, and held on to its T&V-inspired approach. STCP allegedly aimed for a long-term approach with MINADER by integrating FFS in the curriculum of agricultural colleges. Surprisingly, and only after serious probing, it became clear that cocoa FFS did not make it into the revised 2010/2011 school curriculum. MINADER appears to have tolerated STCP's FFS, as funds were made available for something beneficial that Cameroon could otherwise not afford. Real space for institutionalisation and scaling did not exist and, from inception, there was no purposeful engagement with key institutions. A MINADER director stated: 'The vision of coops is very tiny. If you reach [a dozen] cooperatives in a county with about 1.8 million agricultural households, you have done nothing!' During an internal regional STCP management meeting in early 2011, key regional STCP experts opined that the cooperative scaling model was flawed, training numbers were too ambitious, and FFS impact in Cameroon (in terms of farmers reached) was insignificant (first author's notes).

Outside STCP's control, the envisaged future cocoa fund mechanism FODECC did not become operational until STCP was starting to wind down. Even then, it still promised to be a complex procedure involving application to three ministries at the same time, with no clarity about whether a cooperative might be fundable.

5.5 Analytical account of findings and their interpretation: Considering conditions for scaling

Complementing the narrative account of the previous section, this section presents an analytical account along the lines of the dimensions and analytical categories as introduced in section 3 (Tables 5.2 and 5.3). Section 5.1 focuses on the kinds of dimensions (as aspects of experienced reality) that contributed to the performance outcomes of the scaling initiative, and section 5.2 complements this perspective with a focus on the kinds of dynamics that did so.

5.5.1 Dimensions of conducive and constraining factors

Findings from the analysis of conditions for scaling (as summarised in Table 5.5) demonstrate the existence of both conducive and constraining dimensions.

Table 5.5: Summary overview of findings in relation to key dimensions involved in the performance of the STCP/FFS scaling initiative

Group	Summary characterisation of how this played a role
Natural and physical aspects *Quantitative, spatial, kinematic, physical; Biotic, sensitive*	Cameroon's agro-ecology has a potential for high yields of quality cocoa, grown by tens of thousands of smallholder famers. However, formidable challenges exist, such as high incidence of pests and diseases, limited access to improved planting materials, lack of extension provision, and poor road infrastructure. Unsustainable exploitation of fertile forest soils for cocoa causes significant deforestation, causing the loss of biodiversity, and global climate change is increasingly impacting agriculture and the natural landscape.
Human aspects *Biotic, sensitive; Analytical–logical; Formative*	Growing cocoa is motivated primarily by the need for security of income, land tenure, and general livelihood support. Not all smallholder producers have an entrepreneurial focus. Because STCP focused on entrepreneurship, general participation levels were low, resulting in a bias of the programme towards already organised farmers. STCP's management came from a development NGO background and built on that specific skillset, showing confidence in government institutions and favouring cooperatives. At the same time, cocoa being an underresearched crop, the research-led STCP often let academic data needs, knowledge acquisition, or theory development prevail over a focus on development outputs. STCP's service proposition was based on the proven FFS approach with strong underlying principles and came with an expert-written, high quality technical cocoa curriculum. The quality of the innovation was not contested, but the lack of flexibility in the curriculum and its role-out left little room for creativity and alignment with prevailing conditions.
Social and financial aspects *Lingual, social; Economic*	The FFS methodology is uniquely focused on applying a participatory, experimental learning language, which facilitates communication and helps cement relationships and roles at farmer level. STCP initially tried to work with hundreds of smaller farmer associations instead of cooperatives. However, hardly any partnerships were developed with the cocoa institutions. Although cost-effective in the long term, FFSs are relatively resource-intensive. STCP could not manage more than 12 cooperatives, mainly owing to challenges regarding the necessary resources, cooperative contributions, logistics, and timing. STCP did build its own expert institutional capacity and memory, but it was unable to retain this in the long term.
Cultural, political, and moral aspects *Juridical; Aesthetic, ethical, certitudinal*	Cocoa plays a central role in farming systems and associated livelihoods in large parts of STCP's pilot area, and effective cocoa cooperatives and cocoa officials are viewed as providing pivotal services in communities. Cocoa farming is important for them and seen as investment over generations. However, Cameroon's socio-political situation was characterised by a persistent political status quo, strong hierarchy, little incentive for innovation, and under the long-term rule of its president. Resource appropriation by government officials through farmer organisations undermined participation, and smallholder farmers did not expect much support from the government in general.

On the one hand, we found a situation characterised by farmers strongly motivated to make a long-term living from cocoa farming in an agro-ecological zone that is very suitable to cocoa and by a programme introducing an in-principle very suitable approach for addressing challenges faced by cocoa farmers. This presented a good point of departure for STCP. On the other hand, the pathway to scale required dealing effectively and appropriately with the prevalent socio-political conditions and with related organisational structures and institutions, which through their history had made farmers wary about working with government officials. STCP, despite having strong (research) capacity and related values, proved unready to navigate and adjust to socio-political and socio-cultural conditions; this led to a mismatch between the chosen strategic and operational approach and what was actually needed. This demonstrates the need to consider a wide range of dimensions in assessing readiness to guide innovation pathways to scale. An early wider-ranging institutional analysis and feasibility study could have alerted the programme to the need for more caution in the design phase and for flexibility and adaptive management in the scaling phase, even though a strong pilot seemed to indicate that the time was appropriate to take cocoa FFS to scale.

5.5.2 The interplay of conducive and constraining dynamics

Having presented results in terms of the dimensions that proved to be important to take into account and how these played out interactively, in this section we focus on the complexity of the interacting processes and related dynamics that shaped the programme's outcome. The research findings and their interpretation are summarised in four steps: 1) social dynamics, 2) system dynamics, 3) scale dynamics, and 4) management dynamics, reflecting the analytical categories derived from the PROMIS approach (see Table 5.3).

1. *Social Dynamics*

The essential findings regarding social dynamics (summarised in Table 5.6) demonstrate how an initially strong partnership in relation to the introduction of FFS turned into malfunctioning decision-making processes in terms of appropriate participation and discussion of alternative perspectives. STCP's choices with regard to scaling processes soon became rigid, allowing hardly any functional connection with the national extension actors. The obligation to donors and the private sector to achieve a fast return on investment in the form of thousands of trained farmers was a major cause of this.

Table 5.6: Summary of interpreted findings on social dynamics involved in the performance of the STCP/FFS scaling initiative

Analytical category	Summary of interpreted findings
Stakeholders' decision-making dynamics	STCP represented key research, public, and private sector actors. After the FFS curriculum was adapted for Cameroon with broad stakeholder participation through a large network of farmer-based organisations, only a few emerging cooperatives became part of the strategy for the pilot and possible scaling. MINADER/PNVRA was shunned, except for specific technical staff. Initially, private sector involvement was limited. A large donor's requirements drove STCP to gain technocratic control over the process and to further decrease stakeholders' decision making. With external NGO support, existing and newly created cooperatives were nurtured into incorporating FFS, limiting ongoing feedback opportunities. Finally, quantitative scaling – training numbers – became the key driver, under donor pressure, but increasingly also under private sector pressure due to growing impatience.
Diversity of stakeholders' perspectives, social impact	The research-led STCP did not facilitate discussion between conflicting perspectives on extension delivery options and the scaling thereof. STCP and SOCODEVI as key implementers believed in the approach of scaling through cooperatives, although IITA and donors increasingly expressed their reservations about this. Everyone involved strongly appreciated the value of the technical curriculum, but STCP would not consider a different methodology to accompany it in Cameroon. MINADER/PNVRA in principle valued FFS but could not realistically support or responsibly scale it. PNVRA always regarded STCP as a small closed pilot around a valuable but otherwise unadoptable innovation. Fragile and under-supported cooperatives were happy with donors' interventions but behaved as beneficiaries. Five dropped out, and those that remained expressed doubts about the strategy and complained about pressure.

2. *System Dynamics*

The essential findings regarding system dynamics (summarised in Table 5.7) demonstrate how the fundamental absence of institutional space for taking FFS to scale continuously crippled the potential of FFS as such, the potential of the programme, and the potential for emerging partnerships. They also demonstrate how the situation in a country or locality cannot be taken at face value, as initially Cameroon appeared to be more suitable than Cote d'Ivoire (see reference to STCP in Cote d'Ivoire in the introduction), but subsequently proved to have a more rigid institutional context for taking innovations such as FFS to scale; and key stakeholders did not consider this an attractive proposition.

Table 5.7: Summary of interpreted findings on system dynamics involved in the performance of the STCP/FFS scaling initiative

Analytical category	Summary of interpreted findings
Complexity and connectedness	Implementation of cocoa FFS is not particularly complex, nor does it involve many actors. The intervention conflicted with the existing mode of extension provision, the existing regime. Faced with this stalemate, STCP chose to persist, not reorient. STCP minimised external complexity by creating minimal linkages. Internally, the complexity and connectedness was high because of the logic of working within the values, practices, and facilities typical of cooperatives.
Dominance/deviance dynamics	Extension institutions look to politicians for direction. STCP's interactions with either institutions or politicians were almost non-existent. Niche (FFS) and regime (extension system) did not respect each other's discourse (without contesting the innovation's value). The regime was not prepared to integrate FFS because it not was considered scalable within the socio-political context of Cameroon.
System/practice inertia	The regime was rigidly stable, showing institutional and political lock-in, with disincentives for actors to change. In the absence of political decisions or fund allocation, only the status quo could persist.
System/practice instability	The Cameroonian socio-political landscape has been extremely stable, with practically no mobility. True, in the recent past, the dominant regime had experienced deficiency shocks, particularly after the structural adjustment programmes. Thus, with no resources and no alternative capacities to fall back on, the extension system had not sufficiently recovered to adopt novel technologies like FFS.

3. *Scale Dynamics*

The essential findings regarding scale dynamics (summarised in Table 5.8) demonstrate a mismatch between prevalent institutional conditions and emerging institutional realities on the one hand, and STCP's strategic approach and operations on the other. They demonstrate the need to pay attention, and connect, to the dynamic history in which programme are to be located, and the need for strategic foresight, neither of which were addressed appropriately by STCP in Cameroon.

4. *Management Dynamics*

The essential findings regarding management dynamics (summarised in Table 5.9) demonstrate serious deficiencies with regard to the process of engaging with partners and stakeholders, in the capacity for adaptive management, and in the capacity to facilitate the convergence of competing perspectives and orientations. These were not part of STCP's original design, but were also not prioritised over the programme's lifespan in Cameroon later on. Even though during a 10-year programme there was no clear outlook for improvement in the State's (financial) capacity to take FFS forward,

this did not lead at any point to a no-go decision; this further demonstrates the lack of capacity for adaptive management.

Table 5.8: Summary of interpreted findings on scale dynamics involved in the performance of the STCP/FFS scaling initiative

Analytical category	Summary of interpreted findings
Path dependence, past imprinting	Cameroon had previously adopted new approaches, particularly T&V. This logic persisted within its operations, despite resource shortages inducing a shift to micro projects. Earlier pilots on food FFS were evaluated positively.
Anticipated futures	Management did not successfully anticipate ongoing processes or what a scaling-up scenario would entail. It erroneously counted on an emerging cocoa/coffee fund, FFS integration into agricultural colleges, and improving relations with MINADER/PNVRA after management rejuvenation. Soon, STCP's scaling strategy reached maximum capacity, when all cooperative members had been trained.
Cross-scale, cross-domain dynamics	The powerful STCP, supported by the private sector and increasingly by WCF, integrated the latest technologies. FFS was designed to address common challenges and respond to international (consumer) pressure on sustainability and certification and particularly on issues of child labour and pesticide residues. Sector-wide calls for increased smallholder support and training resonated in Cameroon, although some recommendations (e.g. input use) conflicted with existing policy.

Table 5.9: Summary of interpreted findings on management dynamics involved in the performance of the STCP/FFS scaling initiative

Analytical category	Summary of interpreted findings
The process of engaging stakeholders	Sustainably investing in broad stakeholder interaction was not a priority, particularly with the public and private sector. Working with a broad network of farmer-based organisations was initially unsuccessful. A subsequent focus on a rather restricted group of immature cooperative partners and individual government agents during scaling caused a paternalistic style of interaction. STCP's unsubstantiated vision resonated well with the cooperatives' mandate and strengthened their services but failed to attract large numbers of new members or create new farmer-based organisations. Management seemed to lack the institutional and entrepreneurial skills set to successfully navigate a route across the broader institutional landscape and take on the existing socio-technological regime – even if that were possible.
The scope of analysis and evaluation, and preparation/anticipation	At the level of STCP Cameroon, the scaling process was clearly not by design. No scaling process tracing or monitoring was performed. This precluded any opportunity for evaluation, learning, and/or reorientation.

Analytical category	Summary of interpreted findings
The connection between strategy and situational reality	This connection was practically non-existent, and the observation of high levels of 'wishful thinking' was consistently made by most stakeholders outside the STCP team. What remains unclear, however, is why regional researchers and the increasingly powerful private sector did not manage (or dare) to reorient a clearly struggling initiative, but rather let it run its course and expire.
The capacity to facilitate convergence	No evidence of any activity other than impromptu, unstructured high-level dialogue on the topic has been recorded.

5.6.Discussion and conclusions

This section discusses the research findings in terms of an integral consideration of the various research angles. In section 6.1, we identify the key factors and dynamics that were considered of particular importance for understanding what happened in the STCP/FFS scaling process in Cameroon, and we examine which of these provide the best explanation for the failure to achieve the desired results. In section 6.2, we discuss why the multifaceted nature of scaling processes requires matching comprehensive (analytical) perspectives. In section 6.3, we discuss how learning from this study may benefit other (research) initiatives, and in section 6.4 we draw our general conclusion and make suggestions for further research.

5.6.1 Main factors and dynamics causing the programme not to achieve the desired results

In this section, we answer our first research question regarding main factors and dynamics causing the failure of the programme. This is a synthesis of insights emerging from research findings as described in previous sections. We discuss related issues in light of the MLP as visualised in Figure 5.3.

1. *Context for Scaling*

Cameroon, with its political status quo, started the new millennium with top-down agricultural extension services that had been scaled down during the structural adjustment programme and liberalisation, and continued using outmoded extension approaches. STCP, with its focus on FFS, a participatory learning approach, in effect proposed a socio-technological transition to another extension approach (or paradigm). This proved to be unattainable by the government services, which lacked the resources and incentives to challenge the status quo. STCP proved insufficiently equipped to navigate institutional obstacles and complications. We may therefore conclude that FFS in the case of STCP Cameroon never really scaled up from its niche environment because of an absence of interaction and alignment processes with the dominant socio-technical regime. The cocoa sector, and agriculture in general, were

stagnant during the STCP era, and the dominant socio-technological regime was still recovering from system shocks experienced in the 1980s and 1990s. The private sector focused mostly on the main cocoa producers, Côte d'Ivoire and Ghana, and powerful national institutions helped to maintain a socio-political status quo in the absence of clear political intent to provide more resources for extension services (innovative or existing). This was also demonstrated by delays in setting up mechanisms for internal funding. Thus, there were few external pressures or internal incentives for change.

The above characterisation of the situation underscores the importance of contextualising programmes, particularly in scaling processes (Klerkx, Seuneke, de Wolf, & Rossing, 2017). FFS had a strong track record in terms of its potential for engaging farmers in participatory ways to address challenges in agriculture (Braun et al. 2006). STCP was meant to capitalise on this potential, but management paid insufficient attention to the fact that even a model as successful as FFS needs to become institutionally embedded through contextualised processes (Chuluunbaatar & Yoo, 2015).

2. *Readiness for Scaling*

The programme suffered from general management issues that became an impediment to scaling. It seems that STCP Cameroon underestimated what was needed managerially, after the pilot, to appropriately embed an innovation and manage an inclusive scaling process that was not technology-driven. Appropriate guidance is essential, and the idea of rolling out an innovation after successful piloting was – at least in this case – inappropriate. The regional coordination's role can also be called into question. The required capacities within STCP Cameroon and among its national scaling partners for managing the scaling process were not properly assessed and consequently not catered to as needed (Schut et al. 2016). We may therefore conclude that a successful pilot is not an automatic assurance of successful scaling. The financial picture as presented in Table 5.5 further undermined readiness for scaling because of the high costs associated with FFS for MINADER/PNVRA and cooperatives who were meant to co-invest, confirming the cost concern that other authors reported earlier (e.g. Braun & Duveskog, 2008; Davis, 2010). The issue of readiness for scaling may also be considered from a wider perspective on the intended role of FFS. FFS can be a means for extension to convey particular knowledge packages to farmers (which can be useful for the private sector if they connect to particular products and services), but it can also be a means for farmer empowerment, enabling farmers to make their own decisions on the basis of increased access to knowledge, capacity to innovate, and capacity to cooperate (van de Fliert, Dilts & Pontius, 2002). We may argue that, in the case of cocoa FFS in Cameroon, the model focus was stronger than the means focus. This may have led STCP in Cameroon into a model-

replicating mode and the associated rigidity and lack of flexible navigation of institutional realities; and this was further exacerbated by the external pressures to perform along the lines of the model. This accords with learning from the case of farmer livestock schools in Vietnam, which led Minh et al. (2010) to emphasise the need to assess the existing innovation system and then gradually and systematically introduce matching institutional innovations.

3. *Scaling Strategy*

The scaling strategy was chosen on the basis of personal judgement rather than a systematic assessment of all potential options. The choice to spend significant resources on building up a small number of emerging cooperatives appears to have been inappropriate. The data on the three other STCP countries show that these involved national extension through master trainers, right from the start. This confirms the essential role played by skilled facilitators and trainers in FFS and the associated difficulty of extending benefits from FFS beyond the initial groups of farmers and initial pilots, such as discussed by e.g. Braun and Duveskog (2008) and Waddington et al. (2014).

MINADER/PNVRA did not have the necessary political and budgetary backing to adopt FFS, and no other entity could realistically take FFS to scale. It would have been conceivable to put scaling on hold and invest in a lobbying exercise with the government of Cameroon (a member of STCP's regional Executive Committee). STCP's private partners were possibly in a stronger position to put pressure on government, being part of the same PPP. More management foresight might have led rather to a no-go decision on scaling, paying more attention to lobbying and pressing STCP themes such as 'planting materials' and 'pests and diseases'. This underscores the emphasis placed on understanding and engaging with processes of FFS institutionalisation (e.g. by Chuluunbaatar & Yoo, 2015).

An important condition for sustainable scaling success – sustainable national financing mechanisms – did not materialise (at least not fast enough) in Cameroon. STCP's core partners all put pressure on the programme in diverse ways: SOCODEVI was key to the decision to focus exclusively on cooperatives; IITA researchers insisted on intensive data collection; the main donor, the United States Department of Agriculture, dictated ideal type FFS implementation through a rigid log frame approach; and indirectly the private sector put disproportionate pressure on the cooperatives to train beyond their membership base. These dynamics created strong path dependence for STCP's country management who seemingly attempted to meet all the above expectations, possibly against their better judgement regarding scaling and institutionalisation. This again raises the issue of the way in which FFS is perceived: as a model or as a means (van de Fliert et al. 2002).

4. Scaling Approach

The MLP suggests that the objectives of management and donors need to converge, become aligned somehow, with the objectives of all prospective scaling partners (Geels & Schot, 2007). The international (and particularly private) donors' objective to achieve quantifiable impact – training numbers – prevailed however. This should not have come at the expense of paying attention to the complex dynamics involved in processes related to institutionalisation, scalability, and sustainability in the long term (this relates closely to the discussion in section 6.1.1 on FFS as a model to be replicated). The process became paternalistic rather than participatory for the cooperatives, and STCP did not purposefully engage with the other stakeholders in the cocoa extension arena. STCP's claim that a partnership with MINADER/PNVRA was emerging was not substantiated by the data, even though the related wider institutional buy-in was important information for donors and regional management.

Several underlying core principles of the approach were not satisfied, nor accepted at the regime level. The understanding of MINADER/PNVRA about cocoa FFS was in fact close to business as usual. STCP could have insisted in developing broad regime support for more than the technical curriculum and the label. Instead, in the eyes of the regime actors, it adhered to the promotion of its 'brand' type of the FFS approach and the technical cocoa curriculum as a dogmatic package. Working with a high-quality single crop curriculum was in principle quite compatible with MINADER/PNVRA, who expressed appreciation of the curriculum while at the same time making it abundantly clear that it could not adopt FFS. Failing to link up and capitalise on this institutional reality may have been a missed opportunity. This situation points to the importance of (i) flexibility of approach, (ii) the search for alignment, and (iii) the development of joint national ownership for both the piloting and a potential scaling process.

5.6.2 The need for multidimensional understanding of scaling initiatives

Scaling and institutionalising FFS involves a double layer of complexity (Chuluunbaatar & Yoo, 2015). First, there is the approach as such with its core principles (as outline in Table 5.1) and the intricacies of what in this approach connects or not to prevalent conditions in the agricultural sector in general and to prevalent approaches to extension specifically. Also, FFS institutionalisation involves both institutionalisation of principles underpinning FFS and institutionalisation of FFS as an approach (Braun & Duveskog, 2008). Second, scaling processes introduce additional dynamics to be taken into account as discussed in the previous section. The findings from this research help to elucidate this double layer of multifaceted change dimensions and dynamics (Wigboldus et al. 2016) and illustrate how the scaling of a well-defined model involves anything but a model roll-out process. This supports

findings by van de Fliert et al. (2010) who emphasised the importance of a participatory approach, appropriate capacity of researchers and facilitators, and ownership by relevant stakeholders. It also demonstrates the important role of a comprehensive analysis, illustrating how – in the midst of many positive conditions (as was the case for cocoa FFS in Cameroon) – other complicating factors may still outplay their effects. A sufficiently broad-ranging analysis is not just useful for doing a retrospective assessment as we did in this paper, but, as argued in section 5.1, would be even more important as part of preparations for the design and management of scaling initiatives.

5.6.3 Wider application of findings

The findings from this study may be relevant for initiatives worldwide focused on the wider use of FFS or similar participatory learning approaches, but also more broadly in relation to taking agricultural innovations to scale. For instance, the same conditions for, and impediments to, change may apply to the setting up and organisation of innovation platforms (e.g. Kabamba et al. 2014; van Paassen et al. 2014). More widely, the findings underscore the need to take scaling processes in agricultural innovation seriously; this involves appropriate critical analysis, strategic competencies, collaboration, and creative management capacity (Westley et al. 2014; Wigboldus & Leeuwis, 2013; Wigboldus et al. 2016). Many studies on scaling agricultural innovations focus on the achievements of the scaling process (e.g. in terms of adoption or dissemination) and the scaling mechanisms involved (e.g. farmer-to-farmer extension). The approach used here further broadens the scope of analytic dimensions and dynamics that affect, or are affected by, scaling processes such as socio-cultural and socio-political conditions. It can help decision makers to consider what needs to be taken into account in the design, management, and monitoring and evaluation of scaling initiatives, all of which continue to be key challenges in agricultural research and innovation.

The findings support suggestions from recent literature pointing to the need to translate and adapt pilots to specific context conditions and 'best-fit' options, rather than approaching scaling-up as a mere rolling-out process (Garb & Friedlander, 2014; Giller et al. 2011; Shiferaw et al. 2009;). Consideration must be given to the implications of future scaling from a stage as early as innovation design and piloting (Ghiron et al. 2014). The need for specific competencies for guiding scaling initiatives – competencies that go beyond those involved in implementing pilots – has also been noted by others (Hermans et al. 2013; Spruijt et al. 2014; Wigboldus & Leeuwis, 2013; Wittmayer & Schäpke, 2014).

5.6.4 Conclusions

The case of STCP and cocoa FFSs in Cameroon demonstrates that, when an innovation (in this case FFS) has been selected because of its attractive attributes, the scaling-up process involves more than the mere implementation of an organisational roll-out plan. A structured analysis of the institutional landscape, including scenario planning, is needed to identify opportunities and elucidate what a successful scaling process might involve. This would need to include an assessment of regime and context characteristics, including past, present, and anticipated (future) aspects and dynamics; how an initiative would need to engage (adaptively) with identified constraints and opportunities; and the capacities and competencies that would need to be in place to support organisational and relational processes. Guidance on FFS preparation and implementation processes along these lines would enhance the situational effectiveness of FFS. In this, the primary goal would not be to scale FFS as a model to be replicated or as a curriculum to be rolled out, but rather to scale it for the benefit of farmers as (one of the possible) means to empower them.

This paper discussed some dynamics that could usefully be studied more generally, such as the extent to which choosing a particular initial entry mechanism (e.g. small-farmer organisations) to pilot an innovation creates path dependence from which it is hard to escape during the process of scaling and institutionalisation, and how funding mechanisms may create perverse incentives that undermine adaptive management capacity and partnership processes. This also relates to the tension between FFS as a flexible approach (e.g. FAO, 2016) and the high expectations of its instrumentality for achieving impact at scale, which funders of development efforts hold and communicate to programmes. The resulting drive for speed and short-term results may jeopardise one or more of the principles upon which the approach is based, and similar tensions may occur in relation to similar participatory approaches such as innovation platforms.

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List of acronyms

FFS	Farmer field school
FODECC	National Cocoa and Coffee Sub Sector Development Fund
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IITA	International Institute of Tropical Agriculture
IRAD	*Institut de Recherche Agricole pour le Développement*: Institute for Agricultural Research for Development
MINADER	*Ministère de l'Agriculture et du Développement Rural*: Ministry of Agriculture and Rural Development
MLP	Multilevel perspective
PNVRA	*Programme National de Vulgarisation et de Recherche Agricoles*: National Programme for Agricultural Extension and Research
PPP	Public–private partnership
PROMIS	PRactice-Oriented Multi-level perspective on Innovation and Scaling
SOCODEVI	*Société de Coopération pour le Développement International*: Cooperative Society for International Development
STCP	Sustainable Tree Crops Programme
T&V	Training & Visit
WCF	World Cocoa Foundation

CHAPTER 6

Making scale work for sustainable development:

Guiding decision-making towards responsible scaling of agricultural innovations

6

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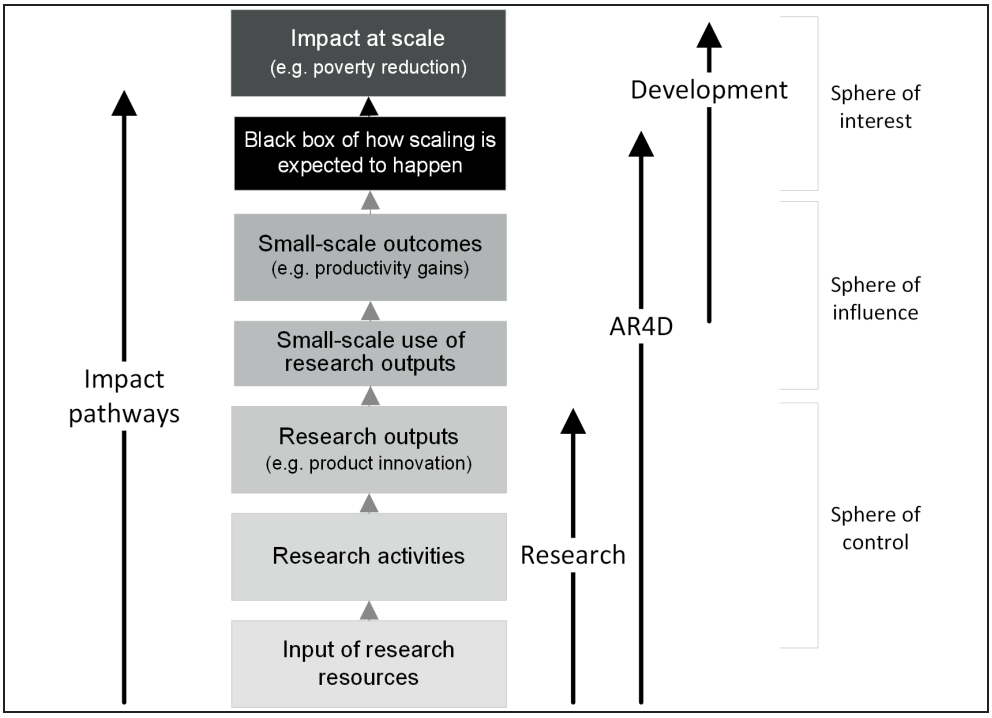
6.1 Introduction

The concept and articulation of theories of change have become widely used in the context of international development by private sector enterprises – for example to define what makes for sustainable farming (UTZ, 2017) – and in agricultural research (Balmann & Valentinov 2016; CGIAR, 2012; Maru et al. in press; Mayne & Johnson, 2015; Thornton et al. 2017). The purpose of such theories of change is to create an overview regarding the way in which aspired change in agricultural systems and value chains is thought to be possible (Maru et al. in press) and to identify key assumptions upon which related expectations are based (Archibald et al. 2016). The articulation of theories of change (and related impact pathways) has become a more common practice in agricultural research and innovation design over the past decade, especially within the concept of agricultural research for development (AR4D). The aim is to support assessment of the appropriateness of proposed research and innovation strategies in light of an aspired contribution to development objectives and to enhance preparedness to navigate related collaborative initiatives towards success (Thornton et al. 2017). The process of articulating a theory of change (ToC) creates opportunities for interaction between stakeholders, elucidating stakeholders' assumptions regarding exactly what change is needed and their potential roles in effectuating change (Grygoruk & Rannow, 2017; Tavella, 2016).

A ToC in the context of research efforts thus aims to reveal plausible connections, through the identification of impact pathways, in a continuum from planned research outputs to outcomes (innovation) and finally to development impact at scale relating to local, national, and global public goods (e.g. Douthwaite et al. 2003; Gaunand et al. 2015; Thornton et al. 2017:152) and the Sustainable Development Goals (SDGs), most articulately stated in the recent Ag4SDGs initiative (CGIAR, 2017). Somewhere on such envisaged pathways, scaling processes are involved. Research outputs may have an indirect relation to outcomes and impact (e.g. dissemination of knowledge through communication channels such as articles, briefs, media messages) or a more direct relationship (e.g. delivery of product and process innovations, that is, new technologies, improved practices that can be used more widely). If agricultural research aims to connect to impact at scale through knowledge, technologies, and practices that it generates, related theories of change are required to elaborate explicitly on ways in which scaling processes are expected to take place (Passioura, 2010). However, as Matt et al. (2017) argue in relation to the impact dimension, much of the question of 'how scaling happens' tends to remain a black box in theories of change and related impact pathways in the context of research programmes, but also in wider development initiatives (Figure 6.1). Darbas et al. (2015) call this the output-outcome gap. Those who do address this gap almost always do so from a purely instrumentalist perspective of 'how to make scaling happen' and rarely explore what

needs to be considered for example to develop appropriate scaling strategies or how to anticipate potentially negative side-effects (see e.g. Gillespie et al. 2015; Oddsdóttir, 2014).

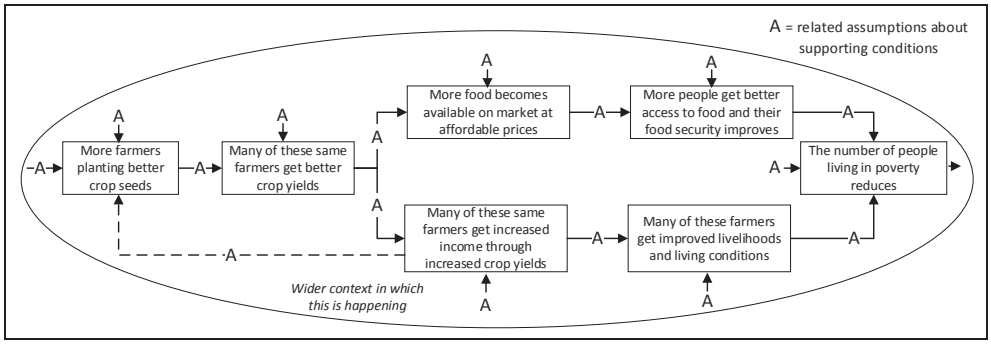
Figure 6.1: A simplified impact-pathway perspective on theories of change in relation to agricultural research and the often missing articulation of assumptions relating to dimensions and dynamics of scaling processes (adapted from CGIAR 2016; Thornton et al. 2017)



Related complexities tend to be left mostly unexplored and unanticipated (see also Apgar et al. 2016; Ely et al. 2014; Wigboldus et al. 2016). As many project and programme proposals include a significant scaling phase, the implication may be that decision makers are not appropriately informed about options for, and implications of, connecting to and engaging with relevant scaling processes. Contributions of research to development impact at scale can be assessed through ex post impact evaluation (e.g. Douthwaite et al. 2003; EIARD, 2003; Maredia et al. 2014; Matt et al. 2017). It would, however, be more effective to enhance the ability for ex ante assessment of ways to appropriately connect to and engage with scaling processes. In addition to results-based management and as part of a ToC, we propose that articulating a specific *theory of scaling* (ToS) could complement current efforts to use theories of change to guide research and innovation programmes towards impact at scale. In this paper, we present a ToS-related framework to help decision makers unpack what is involved in scaling processes and what options for engaging could be considered to make theories of change more scaling-inclusive. Figure 6.2 illustrates

part of what such unpacking involves and illustrates the large number and compound nature of assumptions involved. It also illustrates the need to be realistic about what claims can reasonably be made about links between research, innovations, and aspired impact at scale (Leeuwis et al. 2018). Assumptions may relate to, for example, roles that particular stakeholders need to play (and required capacities involved), environmental and political conditions, and motivation and ownership of primary stakeholders.

Figure 6.2: A simplified illustration of sequential scaling processes involved in impact pathways and related assumed causal relationships



We focus here on theories of scaling in the context of research and innovation initiatives. Such initiatives take place within wider governance frameworks that require them to contribute to political agendas such as the (SDGs), for example by creating incentives and disincentives for particular scaling processes. We are not discussing such governance dynamics in detail here, but we will return to this topic in our discussion section because of its critical role in light of the multitude of scaling initiatives that somehow need to work together towards achieving shared societal goals.

The output and outcome of articulating a ToS using a systematic process such as we suggest in our ToS framework can perform two key functions in support of decision making in scaling initiatives. Firstly, it can provide a shared reference framework regarding scaling processes among stakeholders, involving a) a shared vision for the scaling initiative and related shared scaling ambitions among stakeholders and b) shared assumptions and plausibility structure about what would make for effective and responsible scaling. Secondly, it can support decision making in scaling initiatives by a) helping to consider what is important to take into account in the design and implementation of the scaling initiative, b) raising awareness about different strategic options for engaging with scaling processes, c) raising awareness about specific needs for capacities and conditions in scaling initiatives, and d) addressing scaling-specific monitoring and evaluation (M&E) needs.

In this paper, we address the following questions: 1) which elements of a ToS framework would enable the systematic unpacking of key dimensions and dynamics involved in scaling processes, serving as a structured way to articulate a ToS? and 2) how can such a framework be used to assess scaling initiatives and be part of a wider ToC? In section 2, we present the suggested ToS reflection framework. In section 3, we discuss the six dimensions of the framework in more detail as well as a way of translating it into a decision-making process to guide interactive articulation of a ToS with partners and stakeholders. In section 4, we discuss broader implications in terms of options for using theories of scaling as part of theories of change, specifically in the context of agricultural research and innovation, and reflect on our research questions, drawing conclusions on the potential for articulating theories of scaling to enhance preparedness for effective and responsible scaling, and on the need for further research and development.

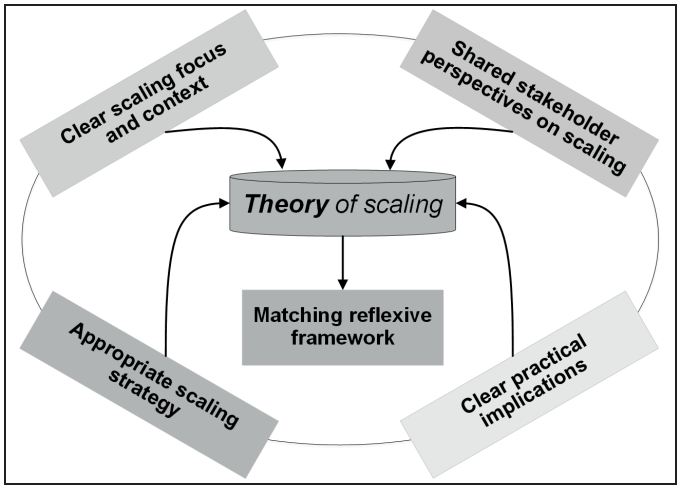
6.2 The ToS framework

Scaling in the context of agricultural research and innovation has been the subject of a large body of research (e.g. Garb & Friedlander, 2014; Hermans et al. 2013; Johansson et al. 2015; Millar & Connell 2009; Rogers, 2003; Wigboldus et al. 2016). We adjudge that the many different angles from which the topic of scaling has been approached are primarily complementary rather than conflicting. In developing a reflection framework for the development of a ToS, we therefore refer to a range of such contributions to show that they together can inform the development of rich perspectives on what to consider regarding 'how scaling happens'. In this paper, we use the general term of 'scaling', which encompasses a range of different types of scaling processes (e.g. outscaling as numerical and geographical spread and vertical scaling as connecting to other levels of decision making – see Millar & Connell, 2009; Hermans et al. 2013; Menter et al. 2004). It relates to both actively promoted processes (e.g. Pachico & Fujisaka, 2004) and processes that are not steered by human actors (natural processes such as related to the spreading of diseases and climate change) (e.g. West, 1999). Scaling may involve human agency but still not be actively pursued and more or less just happen (such as the use of mobile phones in Africa, urbanisation, and also, through greenhouse gases, climate change) (e.g. Bettencourt et al. 2007). Scaling may also be catalysed but then get a dynamic of its own when things 'go viral' (e.g. Chambers, 1992). In commerce, scaling relates to such things as sales numbers, expanding production (capacity), and franchising (e.g. Galitopoulou & Noya, 2016; Gradl & Jenkins, 2011). In results-oriented research, scaling will relate to combinations of any of these types and dimensions of scaling processes.

To build a framework to guide the development and use of theories of scaling, we deduced key building blocks that are part of typical theories of change (see e.g.

Douthwaite et al. 2007; Mayne & Johnson, 2015; Vogel, 2012) and used these to identify what should inform the development and use of a ToS (Figure 6.3):

Figure 6.3: Dimensions of a reflection framework to inform the development of a theory of scaling (ToS framework)



The following briefly identifies what the dimensions pertain to:

1. A **clear scaling focus and context**: considerations regarding analytical frameworks to be used in considering conditions for scaling, characteristics of relevant innovations (which may be technical, institutional, or otherwise) to be scaled, and relevant characteristics of the context for scaling.

2. **Shared stakeholder perspectives on scaling** to guide the development of the ToS: considerations regarding conceptual and practical understanding of what scaling is about and regarding principles to guide the initiative towards responsible scaling.

3. **An appropriate scaling strategy**: considerations regarding options for connecting to, and engaging with, relevant dynamics affecting or affected by scaling processes.

4. **Clear practical implications** for the scaling initiative: considerations regarding putting a scaling strategy into practice in terms of operations that require specific competencies, capacities, collaboration, partnerships, and specific inputs, and that involve specific activities and delivery of products and services.

5. A consolidated **theory of scaling**, which articulates how scaling is expected to happen and for what purpose and the associated assumptions made.

6. A **theory-of-scaling-based reflexive framework**: considerations regarding potential effects of scaling and how this could be monitored and evaluated appropriately to inform the scaling initiative's reflexive practice.

Articulating a ToS can help enhance a scaling initiative's preparedness in relation to these six dimensions in terms of: analytical preparedness, stakeholder preparedness, strategic preparedness, operational preparedness, partnership preparedness (in the

sense of having a shared focus and reference framework through the ToS), and reflexive preparedness (also see Gillespie et al. 2015 who discuss related features of effective scaling initiatives). This also involves zooming in on scaling readiness in relation to the specifics of selected innovations (Sartas et al. 2017). We discuss the six dimensions in more detail in the following.

6.3 Informing the development of a ToS

We discuss the six dimensions in a particular order in the following, but as they partly overlap they need to be considered interactively and iteratively.

6.3.1 Creating clarity about the scaling focus and context

1. Facilitating development of rich perspectives on 'how scaling happens'

Scaling processes involve more complexities than are generally taken into account in scaling initiatives (Wigboldus et al. 2016). Developing a ToS therefore requires the use of analytical tools that help to create rich perspectives on what may affect scaling processes and on what scaling processes may have an effect (including potentially undesired effects). As Kania & Kramer, (2013) have already noted, what defines successful leaders in situations of great complexity is not the quality of decisiveness, but the quality of inquiry.

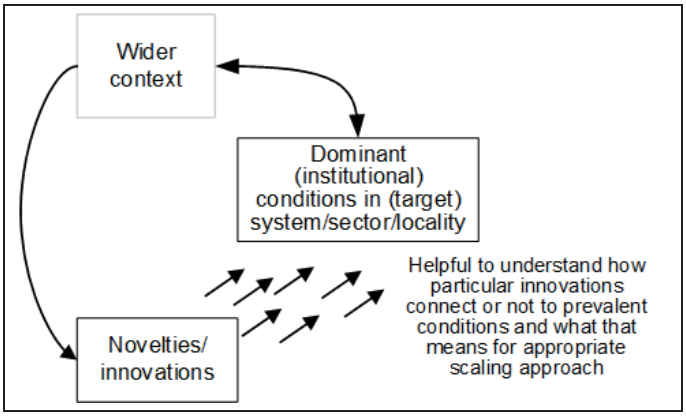
The literature provides a rich basis from which to draw in developing initial perspectives on what needs to be considered in a particular scaling initiative (see Table 6.1). Wigboldus et al. (2016) reviewed several conceptual frameworks that help to create an integrated systemic perspective on options for, implications of, and

Table 6.1: Dimensions of scalability of a particular innovation (adapted from Cooley & Kohl 2006; Holcombe 2012; and Rogers 2003)

The chance of an innovation going to scale increases if the innovation:
- Is feasible and can in principle be used more widely.
- Is credible, based on sound evidence, or espoused by respected persons or institutions.
- Is observable, potential users can see the result in practice; this may involve trialling (on a limited basis).
- Is easy to transfer and adopt, relating to simplicity and ease of use.
- Can be tested without committing the potential user to complete adoption when results have not yet been seen.
- Is suitable for reinvention in terms of modification/adaptation to create ownership and fit-for-purpose.
- Is relevant for addressing persistent or sharply felt problems.
- Has a relative advantage over existing practices.
- Is compatible with existing users' established values, norms, and facilities, not requiring big changes in existing practices.
- Is enabled by conducive communication processes (networks, peer-to-peer).

potential complications in, scaling initiatives (see Wigboldus et al. 2016 for details). They argue that the so-called multi-level perspective (MLP) (Blesh & Wolf, 2014; Elzen et al. 2012; Geels 2002; Hinrichs, 2014) helps create a perspective on the interaction between novelties (innovations) that emerge under specific conditions (niches) and dominant institutional conditions (regimes) in, for example, a sector that may or may not be conducive to scaling particular innovations (Figure 6.4).

Figure 6.4: The utility of the multi-level perspective in considering 'how scaling may happen' – a simplified perspective



Given the limitations of the MLP for grasping detail, Wigboldus et al. (2016) propose Dooyeweerd's theory of modal aspects (Brandon & Lombardi, 2011; Strijbos & Basden, 2006) as complementary, as it comprises a systemic perspective on 15 modal aspects of experienced reality that can help decision makers in scaling initiatives to create an integrated perspective on what may affect, and be affected by, scaling processes (Wigboldus et al. 2016, 2017). Our distinctions of types of scaling (Table 6.2) are based on that theory of modal aspects.

Such integrated perspectives are important, as scaling processes typically cross system boundaries in terms of what affects, and what may be affected by, a scaling initiative. For example, the use of a cropping system innovation often affects wider ecosystem conditions and social dynamics. Aspects such as stakeholder trust and perceptions, which are not easily controllable but nonetheless affect scaling processes, are also part of that perspective.

In general, analytical tools need to be able to help develop an appropriate understanding about a number of things, including: 1) the relevant context (potentially multiple situations) in which the scaling initiative takes place both in terms of origins (e.g. where piloted) and target (the context/s in which scaling is envisaged to happen) – this is further discussed in section 3.2; 2) characteristics of products or processes (innovations) involved; and 3) relevant stakeholder dynamics, in terms both of those affecting conditions for scaling and of those being affected by the scaling processes (in positive or negative ways).

Table 6.2: Spaces for scaling (based on Wigboldus 2016, who adapted material from Cumming et al. 2006; Gillespie 2004; Jonasova & Cooke 2012; IFAD 2011)

Space (conditions) for scaling	***Description***
Natural resource/ environmental space	The extent to which the impact of the scaling initiative on natural resources and the environment must be considered, harmful effects mitigated, or beneficial impacts promoted.
Political space	The extent to which political support for a scaling initiative can be ensured. This may require alignment with political agendas, including such things as the SDGs.
Cultural space	The extent to which there are cultural obstacles and the extent to which the scaling initiative can be suitably adapted to support responsible scaling in culturally diverse environments.
Analytical space	The extent to which appropriate analysis informs decision making regarding the scaling initiative.
Social space	The extent to which the scaling initiative is embedded in conducive (multi-stakeholder) relationships and interactions, and the extent to which appropriate leadership and facilitation can support this.
Partnership space	The extent to which partners can be mobilised to coordinate efforts relevant for the scaling up of the initiative effort.
Legitimacy space	The extent to which the scaling initiative has a recognised mandate from relevant stakeholders to guide collaborative efforts (e.g. mandate for multi-stakeholder partnership).
Capacity/ competency space	The extent to which appropriate capacities and competences can carry the scaling initiative forward.
Management space	The extent to which there is a match between the scale of management (institutions) and the scale/s of the social, economic, and ecological processes being targeted through the scaling initiative.
Facilitation space	The extent to which multi-stakeholder processes relating to the scaling initiative can be facilitated through agents such as brokers and intermediaries, and whether conducive functions can be put in place such as innovation and scaling platforms, hubs, labs, networks, and alliances.
Fiscal/financial space	The extent to which fiscal and financial resources can be mobilised to support the scaling initiative and/or the extent to which the costs of the initiative can be adapted to fit into the available fiscal/financial space.
Learning space	The extent to which knowledge about what does and does not work in scaling can be harnessed through monitoring and evaluation, knowledge sharing, and training, and the extent to which the scaling strategy is dynamic and adapts to an evolving process (no blueprints involved).

2. Considering relevant innovation characteristics and their implications

Whether an innovation is scalable or not and, if so, to what scale level depends amongst other things on the nature of, for example, the innovation itself, conditions

under which it was tested, and conditions under which it is meant to be applied at scale (Table 6.1). The possibility of such wider use and application can only be assessed if we know what exactly is meant to be used or applied more widely. Not necessarily all aspects of, for example, a new production system need to be replicated in scaling, because its success may not hinge on the whole system, but rather on specific aspects of it (Kiptot et al. 2007; Wigboldus, 2016:36). Scaling may therefore also involve adaptation and translation (Coe et al. 2014; Garb & Friedlander, 2014). A key question in considering scalability issues is therefore: what exactly scales (e.g. use of a specific technology or application of a whole production system) on what scale (e.g. numbers, size, speed, intensity) and to what variety of contexts (e.g. geographic).

From a perspective of *responsible* scaling, scalability may be assessed more specifically along the lines of economic feasibility, social acceptability, cultural appropriateness, ethical propriety, geographical determinants, political preferences, and ideological purposes (Wigboldus & Leeuwis 2013). 'Responsible' is then mainly understood from a perspective of virtue responsibility, which roughly translates as appropriate consideration given and care taken in light of relevant concerns and interests (Vincent, 2011).

3. Considering relevant context conditions and their implications

The concept of scaling spaces allows for the creation of an integrated perspective on conditions for scaling; this also links to what we discuss in more detail under other headings. It encompasses the heart of considering options for engaging with scaling processes. Table 6.2 lists a number of such spaces. Scaling initiatives need to consider the extent to which such conditions are conducive or not and what that means for scaling strategy options (Hounkonnou et al. in press).

6.3.2 Creating shared stakeholder perspectives on, and motivation for, scaling

Scaling initiatives invariably involve different partners and stakeholders. A shared perspective on the role and nature of scaling processes, as well as on the way in which they can effectively and responsibly contribute to shared objectives, is critical.

1. Clarifying conceptual understanding

The term scaling is used in many different ways (Fixsen, 2009; Wigboldus et al. 2016). Shared understanding about a scaling initiative's intentions starts with having a shared conceptual understanding.

Different concepts such as scaling up (e.g. increasing production volumes), scaling out (e.g. geographical spreading of the use of an innovation), and horizontal (often understood in the same way as scaling out) and vertical scaling (improving

institutional embedding) are commonly used but sometimes remain a bit fuzzy. Stakeholders often lack a sharp interpretation of what these terms entail and how they are operationalised. Terms around scaling need to be understood in the same way among stakeholders, and it needs to be clear what the scaling is about. In Table 6.3, we suggest a systematic approach to conceptualising different types of scaling processes. Almost always, multiple types of scaling (relating to different scales) will be involved, each potentially having different implications for the appropriate scaling strategy, such as in the case of integrated pest management (IPM), which often comprises a number of different practices and required conditions.

Table 6.3: An alternative way (still incomplete) of distinguishing between different possible types of scaling (adapted from Wigboldus, 2016, who based this on Dooyeweerd's theory of modal aspects, e.g., Brandon & Lombardi, 2011)

Type of scaling (key examples)	***Description***
Temporal scaling	This is about time. Before/after, short-term, long-term: for example, turning an initiative from a short-term project into one with a long-term cross-cutting focus.
Quantitative scaling	This is about numbers. More/fewer in terms of numbers (numeric scale): for example, more farmers using a particular technology.
Spatial scaling	This is about space. More/less spread geographically or larger dimensions (spatial scale): for example, spreading of practice across borders or larger-scale farms.
Kinematic scaling	This is about speed/frequency. Faster/slower (movement) or more/less frequent (movement scale): for example, enhanced mobility or faster connections/transactions.
Physical scaling	This is about energy and power. More/less powerful/energetic/dynamic, more/less capacity (power/energy scale): for example, stronger efforts to change particular conditions or intensification of agriculture.
Functional scaling	This is about functionality and utility. More/less functional/effective/useful (functionality/utility scale): for example, more encompassing farming systems (getting/serving more functions). A project may be scaled up in terms of serving more functions and by doing so better serve a particular purpose.
Social scaling	This can be about social inclusion, such as who benefits, who is in control, etc.
A hierarchy is involved here, where e.g. spatial scaling also involves quantitative scaling (but not the other way around) and where functional scaling involves all preceding types of scaling.	

The essential point made here is that scaling relates to particular scales and, depending on the relevant scale, scaling can relate to different things. Therefore, the question 'at what scale?' can be asked in two ways: 1) what type of scale (e.g. numeric, spatial) applies? and 2) what level on that particular scale (e.g. few or many)

applies? Often a variety of different types of scaling processes will be involved, such as faster transactions, more people involved, and more intensive use of resources. A combination of technical and institutional innovations may also be involved, such as when increased use of a particular technology requires new policies, legislation, or social arrangements (Sartas et al. 2017). Along the lines of what is illustrated in Figure 6.2, it can be helpful in relation to technologies to distinguish between scaling availability, scaling access, and scaling use.

The adoption of a new technology may involve different products and processes that go to scale (in terms of level) on different scales, leading to impact at scale (to a particular level) relating to different scales again. Furthermore, it may involve processes of both scaling up and scaling down. This may be intentional: for example, scaling up the practice of using herbicides while scaling down the practice of mechanical weeding. It may also be unintentionally triggered: for example, scaling up the practice of using chemical fertilisers and thereby triggering the scaling down of plant biodiversity (with consequences of further scaling processes).

Creating conceptual clarity among stakeholders enhances opportunities for informed dialogue on options and their implications, and for developing shared perspectives on what the scaling initiative needs to take into account.

2. Considering relevant principles and orientations to guide the scaling initiative

Theories of change involve fundamental ideas on what makes for progress and development. They are not neutral (Stirling, 2011; Sumberg et al. 2013). Theories of scaling involve that same potential for contestation. This leads to questions such as: Who drives this scaling agenda? What interests are at stake? What histories matter? What consequences can be foreseen? (E.g. Aggestam et al. 2017; Johnson et al. 2016).

Scaling is commonly understood as a process of 'finding out what works and doing more of the same'. This relates to so-called proven innovation and solutions that are meant to be used more widely, by other actors, in new places, and often at larger scale. In this rhetoric, scaling leads to impact at scale. However, what works at one scale level and/or in a particular context does not necessarily work the same way at other scale levels and in other contexts (Cumming et al. 2006; Wigboldus et al. 2016). In the absence of an integrated systems perspective, situations may be created in which positive impact in one sphere of life and for one particular group (e.g. income of large corporations) goes hand in hand with negative impact in another sphere of life (e.g. reduced land security for smallholders). The idea of responsible scaling relates to such considerations (Wigboldus & Leeuwis, 2013). Responsibility in that context includes awareness about potentially undesired consequences of scaling processes that might

have been anticipated and then could have informed different decision making (Wigboldus et al. 2016).

In terms of principles underpinning an ability to go to scale responsibly, we can connect to principles that emerged in the context of the concept and practice of responsible innovation (e.g. van Geenhuizen & Ye, 2014; Shortall et al. 2015). Stilgoe et al. (2013) have suggested four key dimensions of responsible innovation: anticipation, inclusion, responsiveness, and reflexivity. These four dimensions of responsible innovation translate well to the context of scaling processes (Wigboldus et al. 2016). This leads to four key design questions to direct scaling strategy considerations:

1. What are important things for the scaling initiative to anticipate in terms of 'what if this goes to scale', in terms of target situations for scaling, and in terms of relevant future context dynamics?

2. To what does the scaling initiative need to respond in terms of both societal needs and societal concerns expressed by different stakeholders?

3. What does the scaling initiative need to include in its scope for change, who does it need to involve in decision-making processes and in collaborative effort, and who is meant to benefit in exactly what way?

4. What does the scaling initiative need to include in analysis and strategic guidance to inform reflexive and adaptive management in light of the defined purpose?

Other principles may, of course, be used as well, such as how scaling affects resilience and/or sustainability (e.g. de Bruijn et al. 2017). In articulating a ToS, those involved need to consider which design principles should be underpinning their efforts.

6.3.3 Deciding on an appropriate scaling strategy

Articulating a scaling strategy will involve considering trade-offs in light of implications of different strategy choices. Partners and stakeholders may view such implications differently. The choice of strategy will need to connect to relevant required levels of complexity, uncertainty, ambiguity involved, levels of actor capability and knowledge available, and levels of connectivity (between partners, stakeholders) (Wigboldus & Leeuwis 2013).

1. Considering the general strategy

There are many conceivable scaling strategies. Strategies always need to be context specific rather than following standard processes. In relation to multi-stakeholder processes and M&E processes, many experts have been trained over the past few decades to support strategy development. For some reason, no scaling experts have

been trained, even though scaling features as an important dimension of theories of change. This is a gap to be addressed as scaling experts could help stakeholders to think creatively about strategic options. Table 6.4 explores a number of options to consider in designing an appropriate scaling strategy.

Table 6.4: Example options in focusing an appropriate strategy

Focus on adoption of 'solutions' through scaling	<·····>	Focus on system change supported by matching scaling processes
Focus on direct intervention (control/influence)	<·····>	Focus on indirect intervention (catalysis)
Focus on engaging as individual organisation	<·····>	Focus on engaging as broad collaborative effort
Focus on one grand scaling initiative with central leadership	<·····>	Focus on network of multiple interactive scaling efforts related to common goal
Focus on blue-print for scaling (roll-out) i.e. fixed selected innovations to be scaled up	<·····>	Focus on flexible scaling (adaptive/organic/co-evolutionary process guided by reflexive monitoring)
Focus on achieving scale fast and quickly	<·····>	Focus on more 'biological' or 'organic' growth involving gradual absorption
Focus on how to make scaling of particular innovations happen (effectiveness focus)	<·····>	Focus on how scaling can align with wider societal processes and goals (responsibility focus)

A more direct (solutions-driven) strategy will take as its point of departure a technology or practice that needs to go to scale to see its benefits multiplied (e.g. Bozeman et al. 2015), often involving a pilot and followed by a roll-out programme (van de Fliert et al. 2010) – commonly called dissemination and extension. A more indirect (vision-driven) strategy will focus on creating an environment (e.g. achieved through subsidies or legislation) that attracts scaling processes that support the realisation of a vision (e.g. food and nutrition security). What exactly will go to scale is still rather open. This means that the point of departure is a vision for wider system change (e.g. Colvin et al. 2014; Little, 2011; Peters et al. 2012), and there is a realisation that change happens in complex systems (e.g. Douthwaite & Hoffecker, 2017; Ekboir, 2003). Potters & de Wolf, (2014) discuss the case of scaling the IPM application, undertaken through new policies and legislation that created conditions favourable for IPM, rather than by pushing particular innovations.

Different strategy options can be mutually supportive where, for example, policymakers may focus more on enhancing institutional conditions and other actors more on generating options for scaling. Such combinations of scaling strategies happen in larger multi-stakeholder scaling initiatives such as SUN and GAIN (respectively, http://scalingupnutrition.org/; http://www.gainhealth.org/). This

involves forging multi-stakeholder partnerships and platforms in acknowledgement of the multiplicity of interacting scaling processes (Leeuwis & Wigboldus, 2017; Schut et al. 2015). The potential positive and negative impacts that scaling processes can have across time, space, scale levels, and spheres of life are also acknowledged (e.g. Cumming et al. 2006). A research organisation, for example, has limited mandates and influence, so linking research to impact at scale will require collaborative governance arrangements (e.g. Padt et al. 2014) and matching collaborative scaling strategies.

2. Considering scaling methods and their implications

Scaling methods are essentially about the question of how to get from one/few to many, from small to large, from slow to fast, and so forth. Extension services, farmer field schools, and innovation platforms (e.g. Adekunle et al. 2016; Millar & Connell, 2010; Muilerman & Vellema, 2017) are examples of such scaling methods. Marketing, subsidies, and taxation are other possible scaling methods. Different types of scaling methods involve different types of roles to be played by different actors in a scaling initiative (Hermans et al. 2013; Wigboldus, 2016). Table 6.5 illustrates roles to be played in relation to the choice of different scaling methods.

Table 6.5: Possible roles to be played in scaling initiatives (based on Little, 2011; Tayabali, 2010; Westley et al. 2014; Wigboldus, 2016)

Variety of possible roles	***Description***
Marketing	Trying to make certain products or practices go to scale through a variety of targeted efforts. The focus will be on dissemination and transferability (also see Little 2011).
Selling	Through promotion, publicity, or even propaganda, entice people to start making use of certain products or services at scale. The focus may be on branding.
Sharing/ proposing	Generating options, informing people about them, and waiting to see what happens and whether this eventually leads to scaling of innovations. The focus may be on open sourcing.
Facilitating/ enabling	Creating capacities and conditions that make it easier for known innovations to go to scale. The focus may be on cooperation and participation.
Aggregating	Connecting and taking up a full or intermediary role as part of a network or alliance to work on multiple scaling processes with multiple actors in relation to a common (scaling) goal. The focus may be on collaborative networks.
Catalysing	Through e.g. policies and legislation creating conditions for scaling of yet unknown innovations that align with the system/sector/societal aspirations to which those policies and legislation relate. The focus may be on institutional change.

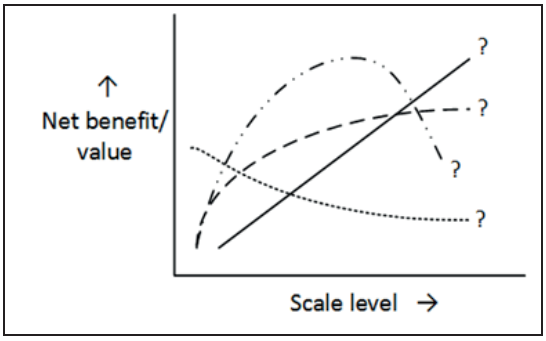
As discussed in relation to complementary scaling strategies, different actors in a scaling initiative may play complementary roles.

3. Considering scaling scenarios and their implications

Scaling scenarios in agriculture are essentially about foresight analysis (Lehtonen et al. 2007; Struif Bontkes & van Keulen, 2003). Scaling initiatives will interact with wider trends and developments, meaning that scaling processes will be part of a complex interaction of a host of scaling processes (Leeuwis & Wigboldus, 2017). Scaling production capacity, for example, may take place while world market prices drop (scale down) and while negative effects on the environment become increasingly visible. Furthermore, scaling the production of one particular crop may increase vulnerability to potential outbreaks of diseases or falling demand in the market.

Finally, there is the big question of 'what if this goes to scale?' Scaling the use of ground water for crop irrigation may lead to dramatic hydrological effects (Hossain, 2006). Decision makers need to develop a sense of a 'return on scaling': up to what scale level (e.g. number of users) will scaling keep adding shared value and at what level can a tipping point be expected? This also relates to developing a sense of how the net benefit/value of, for example, the use of a particular innovation ('net' meaning: in light of all relevant interests) would relate to different scale levels (Figure 6.5).

Figure 6.5: Possible scaling scenarios regarding scale level–benefit ratios (from Wigboldus 2016)



Such scaling scenario analyses may also be conducted regarding the preparedness for scale of different stakeholders and/or value-chain actors, and regarding who would benefit how much at what scale level.

These considerations can inform the weighing of options in light of, for example, anticipated return on investment, linked to predictive models such as probabilistic decision analysis (Shepherd et al. 2015).

Constructing such scaling scenarios and related foresight analysis may be considered one of the most important contributions of a ToS to the enhanced capability of decision makers to engage effectively and, especially, responsibly with scaling processes.

6.3.4 Creating clarity about practical implications of the scaling initiative

The organisation and implementation of scaling initiatives may look very different, depending on the adopted principles for scaling, the relevant context, and the chosen

scaling strategy. The ambit of the scaling may range from a simple project to a multi-stakeholder alliance or network (Ubels & Jacobs, 2016). Central roles may reside more with the private sector, with the public sector, with research organisations, or with civil society organisations. This translates into different requirements regarding partnership development and facilitation, governance and organisational arrangements, and management processes (Gillespie, 2004; Middleton et al. 2002). This may, for example, require inter-donor coordination and capacity development in relation to responsiveness to institutional arrangements (Gillespie, 2004). Related transdisciplinary collaboration and multi-stakeholder processes may also require different ways of working for researchers (Hoffmann et al. 2017; König et al. 2013; Wigboldus et al. 2016 2017). Rather than being located in the scaling phase of a programme, this needs to be considered as early in research planning processes as possible (Ghiron et al. 2014). Some of this will be part of the wider ToC, but preparedness for research and innovation cannot be considered to automatically include preparedness to connect effectively and responsibly to scaling processes (Wigboldus et al. 2016).

These considerations translate into potential implications, including the need for appropriate competencies and capacities to deal effectively with pertinent scaling conditions and requirements; the need for appropriate collaborative arrangements (e.g. partnerships, alliances) with relevant actors who may significantly affect, or be significantly affected by, the scaling initiative; the need for the provision of appropriate programmatic arrangements and incentives, including realistic expectations about what single actors can achieve in terms of impact at scale; and the need for a 'navigation plan' that allows for adaptive response to the realities encountered as the initiative unfolds.

As noted earlier, scaling processes as a topic is, unfortunately, not yet a specific field of expertise for which training and education are available. As a result, scaling initiatives are often managed by people who may be experts in the field of research and innovation (even in piloting options) but lack knowledge and expertise in the field of the complexities involved in scaling processes.

6.3.5 Consolidating and articulating the ToS

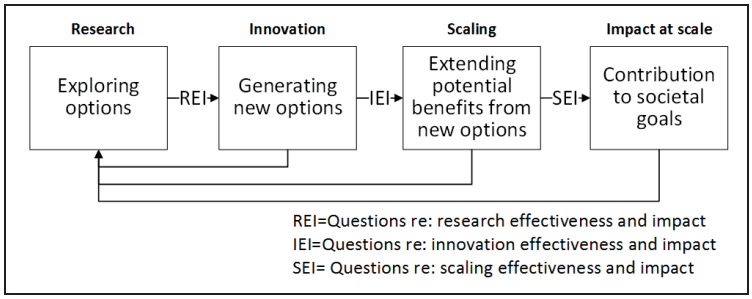
The consolidated ToS is not a scaling model, but rather an articulated shared perspective on how the scaling initiative would plausibly achieve its objectives (Douthwaite et al. 2003 2013; Mayne & Johnson, 2015; Springer-Heinze et al. 2003; Thornton et al. 2017). It may be rendered in all kinds of visual formats in the same way as theories of change are visualised (van Es et al. 2015; Vogel, 2012) and will comprise at least the following three components: 1) a timeframe showing interaction between

processes, actors, and dimensions, as well as their anticipated sequencing over time (representing a view on assumed causal relationships); 2) key assumptions underpinning the ToS in terms of how scaling is expected to happen (including about relevant partnerships, alliances, and network arrangements, and about roles to be played and capacities needed (e.g. Archibald et al. 2016; Christiaensen, 2017; Shortall, 2017; Ton et al. 2015); and 3) critical uncertainties about causal relationships, actors' activities, and the way in which various processes may play out.

Many theories of change focus on spelling out a logic underpinning the expected change process without identifying (assumed) critical operational change mechanisms such as regarding the ways of partnering, coordinating, facilitating, or managing that are considered effective for triggering change under relevant circumstances. It is critical that such considerations are indeed part of a consolidated ToS to prevent the reduction of the ToS – after all the explorations in relation to scaling conditions, contexts, strategy options, and practical implications – to a simple logic model in which the richness of the articulation process is largely lost.

If donors and other stakeholders explicitly accept the plausibility of the ToS, this creates a basis for 'being in it together'; this can help prevent having to prove effectiveness through mere achievement of predefined scaling targets that may both be unrealistic and create a culture of mere target achievement (Douthwaite & Hoffecker 2017; MacCormack 2014). This also relates to roles and responsibilities along impact pathways and the need for appropriate expectations about related contributions to impact (Leeuwis et al. 2018), as sketched in Figure 6.6.

Figure 6.6: A simplified perspective on roles to be played along impact pathways from research to impact at scale



As is the case with theories of change in general, a ToS, rather than being a fixed guidance instrument, will need to be revisited and, if needed, revised over time as it becomes clear how the scaling initiative is faring in reality.

6.3.6 Defining a ToS-based reflexive framework

To understand how a scaling initiative is faring, we suggest four points of reference: the extent to which 1) understanding about the scaling focus and context and related assumptions are found to be correct and valid; 2) the scaling strategy (strategies) and

related assumptions are found to be appropriate and effective; 3) the consolidated ToS is found to be a sound basis for strategic and operational management of the scaling initiative; 4) the strategic and operational management of the scaling initiative is found to be appropriate and effective. This needs to be complemented by processes that assess emerging effects of scaling in light both of intended benefits and of possible unintended (side-)effects.

A well-articulated ToC, including a ToS, will spell out key assumptions, critical uncertainties, and (causal) connections between actors and factors that are expected to lead to aspired impact at scale. In sound M&E practice, this translates into strategic questions: how will we know our assumptions turn out to be valid, that uncertainties are not turning out to relate to major obstructions in the impact pathway, and that change is coming about as envisaged (Kusters et al. 2017)? If questions are clear and relevant, the programme knows what it needs to know and can define its information needs at different points in time.

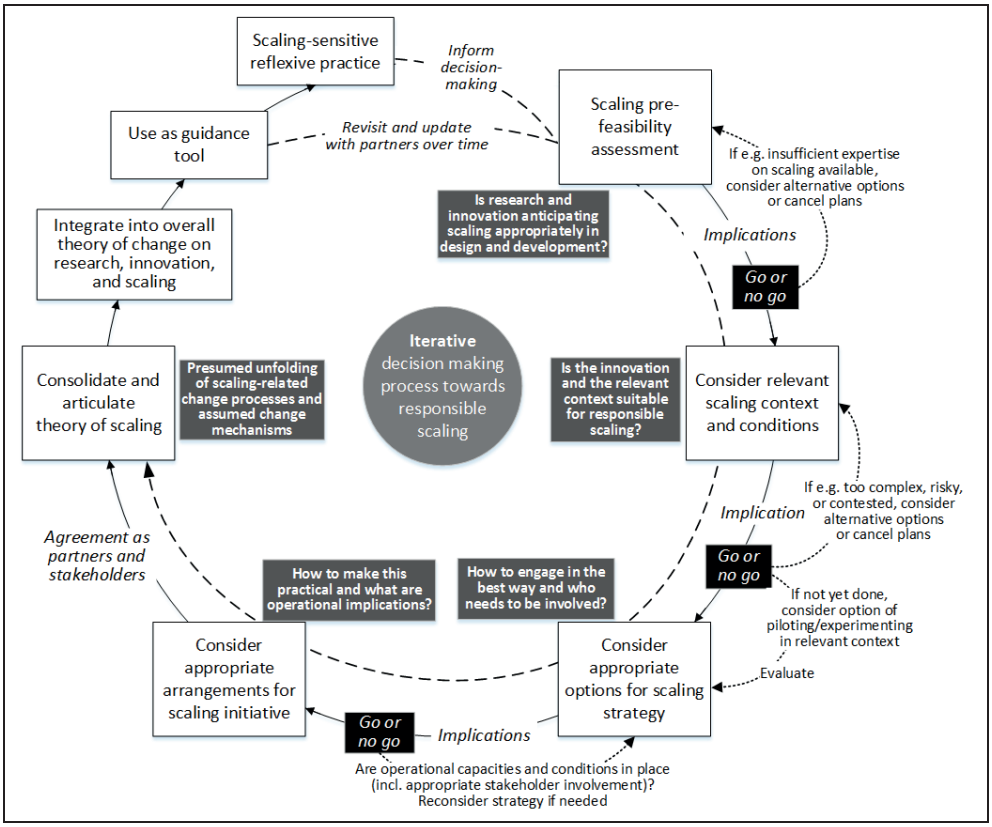
Scaling processes are usually influenced by different actors, and related effects often occur over a timespan of many years. This complicates attribution claims; many actors may claim the same impact, and impact assessment may therefore make little sense if it is done only in relation to separate initiatives (Ton et al. 2011 2014; Maru et al. in press). Contribution analysis (e.g. Befani & Mayne, 2014; Delahais & Toulemonde, 2012; Mayne, 2001) is one of the ways to address this situation.

Negative impact (but also positive impact) may occur long after a particular initiative has ended (Sabiha et al. 2015; Urruty et al. 2016). This may cause complications in multi-actor settings and long-term impact of scaling processes: who is responsible for keeping track of what? This underscores the importance of informing policymaking and governance processes with big-picture and long-term perspectives on the way in which a multitude of scaling initiatives work out in complementary or conflicting ways in light of societal goals (Gee et al. 2013; Padt et al. 2014; Stilgoe et al. 2013). We return to this concern in our discussion.

6.3.7 From ToS framework to decision-making processes

In the previous sections, we discussed building blocks for developing a ToS. Figure 6.7 presents a perspective on how this may be translated into a stepwise decision-making process. Such framework may, for example, inform an interactive workshop with partners and stakeholders, probably as part of a wider process of developing a ToC for a collaborative effort. Specifics may be further detailed and tailored to the context of, for example, such workshops.

Figure 6.7: An overview of iterative steps in a process of articulating a theory of scaling



6.4 Discussion and conclusion

We started this paper by asserting that scaling dimensions of theories of change tend not to be sufficiently elaborated, thereby limiting capabilities of decision makers in scaling initiatives to deal effectively and responsibly with scaling processes. We have therefore introduced a framework to support the adoption of a systematic approach to the articulation of a ToS, to be used as a tool for reflection and decision making by:

- Researchers and managers of scaling initiatives who need clear perspectives on how their efforts contribute to impact at scale;
- Policymakers who need to better understand the effect of policies, subsidies, and interventions on scaling processes; and
- Donors who need to know what makes for preparedness of initiatives to engage effectively and responsibly with scaling processes.

The process of articulating a ToS and the resulting product can help inform decision makers to make appropriate choices on how to connect to and engage with scaling

processes (Table 6.6). A ToS should not become a standalone product separate from the general ToC, but rather be an integral part of it. Such scaling-inclusive ToCs can highlight the importance of a collaborative perspective on scaling initiatives, the need to anticipate scaling processes and define related implications for research and innovation design, and the need for interactions with partners and stakeholders early on in research and innovation in anticipation of envisioned scaling.

Table 6.6: Potential contribution of the articulation of theories of scaling to the practice of scaling initiatives

Limiting practice in scaling initiatives	***Potential offered by ToS-based scaling initiatives***
Mere rhetoric on scaling in proposals	Carefully thought through scaling approaches that include considerations about who drives scaling and why
Wishful thinking about anticipated scaling regarding how it would happen as well as regarding its wider effects and implications	Transparency about ambitions, ideas about how scaling is expected to happen and would benefit the right people and about related assumptions
Considering scaling always to be a good idea if a related innovation is considered to have its merits (e.g. seen as 'a solution')	Awareness that the quality and impact of an innovation is co-determined by its original context; alertness to the fact that at scale and in other contexts (ecology, institutional, social, etc.) performance and effects of innovations may work out quite differently
Scaling processes considered only after initial research and innovation efforts	Scaling processes anticipated and taken into account in scaling-anticipatory research and innovation design and implementation
Narrow, silver-bullet-focused scaling strategies	Well-considered, contextualised, complexity-aware, and creative scaling strategies that are also informed through strategic foresight analysis
Organisations trying to make things go to scale through mainly their own effort	Timely development of effective networking, alliances, and partnerships as a basis for a collaborative approach to scaling
Lack of articulated scaling narratives in proposals that include assumptions about how scaling is thought to work out	Insightful scaling narratives creating shared perspectives and a sense of shared direction in multi-stakeholder partnerships in scaling
Trial-and-error scaling initiatives	Scaling initiatives ready to engage effectively and responsibly with scaling processes through anticipatory, responsive, inclusive, and reflexive decision making
Being oblivious to potential negative impact at scale	Strategic foresight supports future-ready scaling initiatives that have considered potential implications of, and trade-offs involved in, scaling, including considering potential effects across scales and social, economic, and environmental system boundaries

The process of articulating a ToS may enrich existing diagnostic and planning approaches such as the rapid assessment of agricultural innovation systems (e.g. Schut et al. 2015), participatory impact pathway analysis (Alvarez et al. 2010; Douthwaite et al. 2007), and the practice of results-based management, which is increasingly being

applied in relation to agricultural research efforts (Schuetz et al. 2014). Quick-scan explorations such as facilitated through soft systems methodology (e.g. rich pictures) and interviews with selected focus groups and key informants can help prevent the articulation of the ToS from turning into a research project on its own (Wigboldus et al. 2017).

In this paper, we focused on theories of scaling in the context of specific scaling initiatives related to agricultural research and innovation. Societal goals such as the SDGs also require a wider (policy-based) ToS perspective that considers how a multitude of scaling initiatives perform interactively in light of these goals. Scaling initiatives that contribute effectively to one of the SDGs may work out negatively for another SDG. For example, growing crops for biofuels may contribute to increased access to renewable energies (SDG 7), but also go hand in hand with land grabbing (SDG 1) and reduced food security for certain groups (SDG 2). Also, what appears to be an attractive innovation in small-scale and/or particular contexts may work out quite differently at scale, in other contexts, and in interaction with other conditions or innovations, including other innovations at scale (Raworth, 2017; Rockström et al. 2009).

This perspective underscores the role of scaling-sensitive policymaking that defines the policy space for scaling processes. Policymakers need to consider sector-level and/or society-level theories of scaling when defining, for example, incentives and disincentives (such as subsidies or penalties) for agricultural and industrial development, as they are actively stimulating (or stopping) scaling of innovations through these measures. The focus of policymaking tends to be on considering what innovations match policy perspectives, without considering whether such innovations at scale (and in different contexts) would still match related intentions (Kanie & Biermann, 2017; Padt et al. 2014).

The reflection framework suggested for articulating theories of scaling is a first step towards making the idea of theories of scaling more concrete. And, as briefly discussed above, it would be good to further extend this to the field of policymaking and governance. More field-testing in relation to different types of scaling initiatives, a description of process facilitation, and further development of guiding frameworks are needed. As discussed in relation to scaling strategy, there is also a need to develop specific expertise in the field of guiding scaling initiatives and in the field of scaling-sensitive policymaking, much along the same lines as expertise in the field of M&E and in the field of multi-stakeholder partnership has been developed over the past few decades. As far as we know, scaling processes have thus far not been considered a particular field of expertise, as few if any training workshops or other educational efforts appear to be advertised. We would argue that this has limited both the

effectiveness and the appropriateness of scaling processes. The ToS framework discussed in this paper may also be considered as a tentative outline of a curriculum for training experts in responsible scaling.

Acknowledgements

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CHAPTER 7

Discussion and conclusions

7

7.1 Focus of discussion

Since I started this research, the popularity of (framing ambitions as) scaling innovations for development and progress has increased in the context of international development and certainly also in the context of agricultural (research for) development. This has, however, still not gone hand-in-hand with a serious (re)consideration of the ideological roots and fruits (societal effects) of related approaches, with a few exceptions discussed later. The focus of this thesis, *rethinking* the idea and practice of scaling innovations for development and progress and what this implies, is therefore as topical as when I started this research in 2013. All the while, potential and actual negative implications of scaling innovations have been significant and serious, as discussed in Chapter 2. Scaling innovations has triggered a crossing of multiple points of no return in relation to e.g. planetary boundaries (Mathias et al. 2017) and has led to escalating human–biosphere interactions (Hughes et al. 2013). Economic growth has replaced vast areas of enormous complex natural ecosystems with much simpler systems – in ecological and biological terms – of agriculture, industry, and urban living. Even the chemical balances of vast bio-geophysical systems – the atmosphere, oceans, forests, soils – have been disrupted (AtKisson, 2012). Innovations and their consequences scale faster today than ever, whereas the absorption capacity for error in scaling is smaller than ever (Hughes et al. 2013). If things scale faster, potential errors and negative effects scale faster as well. Continuing to scale new and allegedly better innovations will not address this situation unless serious questions are asked regarding what should keep growing, what should stop growing, what should shrink/be reduced.

In this last chapter, I discuss what this rethinking process has yielded in terms of new perspectives on the nature and implications of such scaling, new analytical frameworks for unpacking and assessing the multifaceted dimensions and dynamics of scaling processes, and new designs for guiding decision making in scaling initiatives. Those are the three main research areas as outlined in Chapter 1:

Rethinking perspectives on scaling innovations for development and progress:

1. What type of thinking, ambitions, and orientations commonly underpin and motivate the essential idea of scaling innovations, and what are the related biases, complications, and societal concerns?
2. What types of negative effects can scaling innovations have on nature and society and what helps to better anticipate and reduce such effects?

Rethinking analytical approaches for considering scaling innovations for development and progress:

3. What commonly informs management processes (including design and strategy) relating to the scaling of innovations, and what are the related limitations and vulnerabilities?
4. What analytical approaches, methodologies, and frameworks can help enrich perspectives on the implications of scaling innovations and what dimensions and dynamics do these need to take into account from design to evaluation of scaling initiatives?

Rethinking processes for informing scaling initiatives towards a practice of responsible scaling:

5. What can we learn from the empirical application of alternative analytical approaches in assessing a scaling initiative retrospectively (ex post) and prospectively (ex ante)?
6. How can decision-making processes (including policymaking) benefit from the suggested methods and approaches as discussed in relation to the above five questions towards advancing what may be framed as responsible scaling practice?

I discuss my findings along four lines: a discussion of 1) findings in relation to the above six research questions (section 7.2); 2) wider implications of these findings in light of both scientific and societal debates and concerns (section 7.3); and 3) needs for further research and development (section 7.4). In section 7.5, I conclude this thesis with a brief overview of the essence of what I found out through this research.

7.2 Rethinking the idea and practice of scaling innovations: key findings

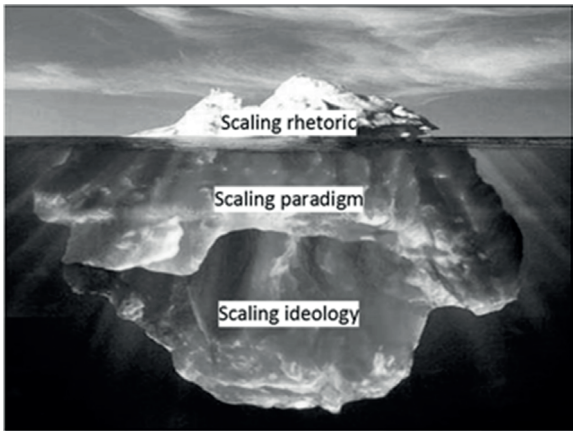
This section presents a synthesis discussion of each of the research questions as described in Chapter 1.

1. What type of thinking, ambitions, and orientations commonly underpin and motivate the essential idea of scaling innovations, and what are the related biases, complications, and societal concerns?

This thesis (particularly Chapters 2 and 3) demonstrates how the scaling of innovations has been at the heart of societal change even long before change processes were framed that way. It also demonstrates the inherent risk of distortion involved in scaling innovations. The picture that emerged is that of the idea and practice of scaling innovations being deeply anchored in ideologies related to development and progress, in a paradigm of perpetual growth, which is promoted through a rhetoric asserting the necessity for such processes. Some raise the objection that these days technologies and wider innovations are much better aligned with sustainability requirements than before, or even are the very agents of bringing sustainability. This thesis challenges this objection by arguing that such approach remains within the core ideology of

technology, saving the world from what (earlier) technologies helped to cause. As such dependence on technologies is part of hotly debated visions for society, ambitions to scale innovations also need to be addressed in such debates. Currently, this is hardly the case, because it is commonly reasoned that scaling (up) what is good (a particular innovation) will lead to more of that 'good'. Even though most people acknowledge logical problems in such reasoning, it nevertheless appears to underpin most ambitions to scale innovations (see Figure 7.1 for a visualisation of the need for an integral perspective on the rhetoric, the paradigm, and the ideology involved in ambitions to scale innovations). Part of the reason for this may be found in competition for funds to develop programmes and initiatives, leading to inflated value propositions. The current *Zeitgeist* appears to favour proposals that promise impact at scale. Chapter 2 presents a big-picture perspective, pointing to three directions for doing so: 1) Directing eyes towards what matters most in life, zooming in on two cases (a non-material and a material): justice and the soil; 2) developing an ethics of scaling innovations as an extension of the ethics of technology, of innovation, and of responsibility; and 3) expanding the already well-known idea of responsible innovation towards responsible innovation and scaling, and by doing so taking more seriously the distinct dynamics involved in scaling processes. One of the key issues raised in Chapter 2 is the question of whether things that matter most in life can be 'scaled up'. The rhetoric of scaling, whether implicitly or explicitly, focuses on the material side of things. Scaling up justice, (self-giving) love, stewardship, to mention three examples, are rarely part of such rhetoric. As argued by Goudzwaard et al. (2007), the tendency is to translate such things as 'quality of life' into mostly quantifiable (material) features; into things we can control, even if they are only part of, and/or secondary to, what more fundamentally makes for quality of life.

Figure 7.1: Simple visualisation of interrelated dimensions of what underpins ambitions to scale innovations



In relation to this research question, I presented a critical perspective on the idea and practice of scaling innovations for progress and development that needs to be critiqued as well to further develop philosophical perspectives on the subject matter, which are currently rather rare.

2. What types of negative effects can scaling innovations have on nature and society and what helps to better anticipate and reduce such effects?

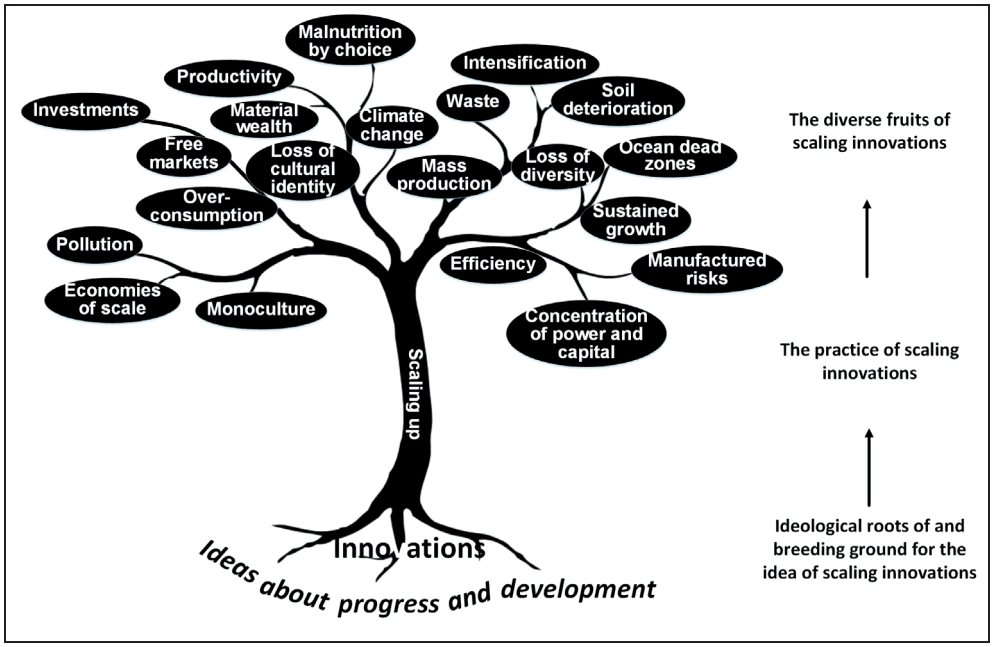
Chapters 2 and 3 discuss various types of effects and implications of scaling innovations. Examples of negative effects include depletion of natural resources, including the draining of lakes (such as the Aral Sea in Central Asia) and the depletion of ground water, affecting its quality (such as in Bangladesh). It is important to note that the negative effects resulted from positive intentions such as to increase agricultural production and improve livelihoods. Good intentions are not a guarantee of good effects. A broader observation is made that most of the grand challenges facing humanity originated from applying innovations at scale, including in the case of climate change. Chapter 2 explores distortive implications that are inherently linked to scaling innovations and identifies major societal trends as being linked to scaling innovations. It presents a clear picture that scaling innovations can and does have positive effects, but that negative effects are never far away and are often happening simultaneously with the positive effects, though in different spheres of life. Scaling innovations may therefore be compared to a tree bearing two different types of fruit, good and bad (see Figure 7.2). One of the core arguments of this thesis is therefore to anticipate such negative effects and design and manage in ways that address such potential for negative effects. I was tempted to state that it depends on the type of innovation (technology) whether there can or will not be such negative effects, but this thesis research made it clear that any type of innovation (technology) used beyond a particular scale level runs the risk of producing negative effects. This is the basis for the argument of the need for a responsible scaling approach. This will not prevent all mistakes and will still involve surprises, but at least it will align with principles of responsible practice (or even principles of precautionary practice). The European Environmental Agency's (EEA) publication *Late Lessons from Early Warnings* (Gee et al. 2013) presents an overview of implications of the use of particular technologies at scale (though not framing it as scaling innovations). It would be useful if a systematic overview (or catalogue) were developed of innovations that led to serious negative effects even though initially having positive effects or having positive effects for some groups and/or some locations. It would help provide a stronger argument for the need for responsible scaling. This would also help to show that it does not suffice to focus on responsible innovation, because an innovation as such may be good in a particular context and used at a particular scale level, but, in a different context and at scale, this may change.

Together, Chapters 2 and 3 present a perspective on responsible innovation *and scaling*. They point out why ambitions to scale innovations need to move towards clearer perspectives on what makes for responsible practice, notably because of the inherent potential of creating distortions consequent to changes in proportions and

ratios, because of the limitations in the common linear and reductionist approaches associated with scaling innovations, and because of the misguided pro-scaling bias. Such perspective and related practice help to take processes of scaling innovations and their implications more seriously along a number of lines:

- By addressing logical fallacies and reductionisms involved;
- By acknowledging ideologically motivated ambitions;
- By connecting the idea of scaling innovations to relevant wider societal concerns and debates;
- By extending the concept of responsible innovation, which allows for building on what has already been developed along those lines while offering complementary perspectives on scaling processes;
- By offering ways of operationalising principles of responsible (agricultural) investment by linking such principles to the practice of scaling innovations, which features prominently in such investments;
- By offering ways of operationalising concepts such as ecosystem tipping points and planetary boundaries by linking such operationalisations to the practice of scaling innovations, which contribute significantly to concerns about a safe operating space for humanity;
- By offering ways of extending the concept of scale-sensitive governance (e.g. Padt et al. 2014) to the governance of scaling innovations. I discuss this further in section 7.3.5.

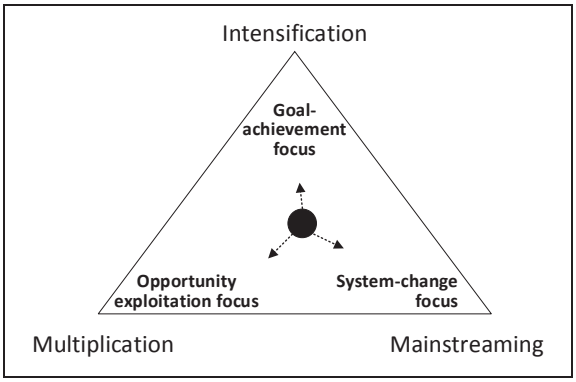
Figure 7.2: By which fruits are we to tell the nature of the tree? The mixed bag of positive, contested, and negative outcomes of scaling innovations for development and progress.



3. What commonly informs management processes (including design and strategy) relating to the scaling of innovations, and what are the related limitations and vulnerabilities?

Figure 7.3 summarises common approaches to scaling innovations along three lines. The first type concerns scaling innovations to achieve particular (societal) goals. Scaling innovations in this context can often be characterised as a process of intensification of effort (to achieve goals). Examples of this type include ambitions to 'scale up (impact on) nutrition'. The second type concerns scaling innovations to exploit an opportunity that has been presented in the form of any kind of innovation. Scaling innovations in this context can often be characterised as a process of multiplication, where positive outcomes are assumed. Examples of this type include improved crop varieties. The third type concerns scaling innovations as part of system change. Scaling innovations in this context can often be characterised as mainstreaming so as to support the move in the direction of a desired system change, aligning with related agendas. Examples of this type include the application of integrated pest management in agriculture in order to move towards more sustainable agricultural practice. Scaling initiatives will usually relate to more than just one approach.

Figure 7.3: Three main scaling innovations approaches related to different purpose orientations



More generally, the common approach to the management of scaling initiatives is 'to find out what works and to do more of the same'. I have challenged this approach as not doing justice to the complexities involved in scaling processes. In Chapter 3, I discussed how it is increasingly recognised that the transfer and dissemination, and related to that the diffusion and adoption, of technologies and practices are not linear processes; rather, substantial reworking of technologies and practices happens in scaling processes. However, approaches to scaling using concepts such as adoption, transfer, and dissemination still tend to focus mainly on attributes of technologies and adopters that determine adoption likelihood. They do not always prepare prospective users sufficiently to engage with the systemic and complex dynamics involved in, and resulting from, scaling processes. Adoption thinking tends to remain focused on informing interventions (e.g. policies) aimed at farm level and is less explicit about interventions that create a conducive environment for change overall (e.g. by

changing value chains and markets, consumption patterns, citizens' values). Furthermore, adoption approaches and studies tend to focus on transfer and dissemination success, such as the number of farmers using a particular technology, and much less on long-term, cross-domain, and cross-scale consequences of dissemination and diffusion. Technologies and practices that are perceived as sustainable and inclusive may even work out quite differently when applied at large scale or under different ecological, geographical, or political conditions. I have therefore argued in Chapter 3 that, rather than being considered as the logical follow up to the introduction of novel technologies and practices resulting from successful research and innovation, scaling should be considered as part of a more continuous process involving ongoing finetuning.

4. *What analytical approaches, methodologies, and frameworks can help enrich perspectives on the implications of scaling innovations and what dimensions and dynamics do these need to take into account from design to evaluation of scaling initiatives?*

Chapter 3 followed up on questions raised in Chapter 2 by considering what (analytical) frameworks and methodologies could help improve the performance of scaling innovations towards something that may be called responsible scaling. This led to the introduction of PROMIS as a framework and perspective to help unpack the multifaceted dimensions and dynamics to be considered in relation to scaling innovations. The essential way in which Chapter 3 addresses such multifaceted picture of what is involved in scaling processes is by combining a big-picture perspective on related dynamics with an integrative perspective on related dimensions. This involved the adaptation of the multi-level perspective (MLP) and the theory of modal aspects to fit the purpose of the particular type of framework needed. It first and foremost points to possibilities for creating richer perspectives on what needs to be taken into account in decision making relating to the scaling of innovations. Chapters 4 and 5 further refine this towards research methodologies for application in empirical research, and Chapter 6 presents a more simplified methodological perspective.

Increasingly, management processes relating to the scaling of innovations are guided by articulated theories of change. Such theories in principle include a perspective on 'how scaling is expected to happen'. However, in practice, this scaling dimension of the theory of change tends to remain a black box of (often unarticulated) assumptions. As a result, many projects that have an ambition to scale particular innovations run into complications for which they have not been prepared. The theory of change approach offers good opportunities to explore and articulate ideas on how scaling can happen. That is why in Chapter 6 I develop an approach for articulating theories of scaling that builds on existing experiences with wider theories of change. Several groups (e.g. the CGIAR Roots, Tubers, and Bananas research programme) have started

to work with processes of articulating theories of scaling (though not necessarily along the same lines as I present in Chapter 6).

5. What can we learn from the empirical application of alternative analytical approaches in assessing a scaling initiative retrospectively (ex post) and prospectively (ex ante)?

Chapters 4 and 5 work with PROMIS to explore possibilities for operationalising this perspective in research and development practice and to consider how a perspective on responsible scaling can be translated to a research setting. Chapter 4 considers the history of rubber cultivation in Southwest China, which is a typical example of excessive scaling leading to serious environmental and cultural degradation. Rubber brought financial economic affluence to many, but stakeholders across society have come to worry about its wider consequences. The idea of 'green rubber' represents the idea of reducing such negative consequences. PROMIS was used to create a comprehensive picture of what would need to be considered in moving towards 'green rubber' practice, and what it would take to move in that direction together as multiple stakeholders. The case study confirmed the relevance of taking into account the wide range of topics to which PROMIS helps connect. It became clear that there will often not be the time and wider capacity to do in-depth studies (along the lines of all that is part of PROMIS), for which reason the study involved what was called a quick-scan. That worked out well and may be the more practical way of using PROMIS. It involved a simplification of tools by combining the more analytical focus of PROMIS with more participation-focused tools and processes such as the rich picture and scoring in relation to a variety of dimensions of the topic area. The study also showed the importance of some group or agent playing the role of facilitating the development of integrative perspectives to inform and inspire stakeholder interactions and emerging partnerships. Such role includes the translation of more comprehensive perspectives on relevant complexities into clear take-away messages for stakeholders. This also relates to what we explore further in section 7.3: the governance of scaling innovations. It became clear that not everyone (stakeholder group) can handle comprehensive perspectives on relevant complexities, even though it is important to take them into account in scaling initiatives.

Chapter 5 presents a retrospective analysis of the case of scaling the application of cocoa farmer field schools in Cameroon, which may be considered a typical example of de-contextualised scaling. It uses elements of PROMIS as a lens to study the case, which is mainly about uncovering core reasons for the disappointing outcomes of a programme that aimed to see cocoa farmer field schools go to scale in Cameroon. It is a rather different study than the study on green rubber, as it involved working with existing data and there was no way of adding new data to address questions emerging from PROMIS more fully than was possible with the existing data. This limited the scope of what could be addressed, even though the study did lead to some clear

learning. However, this case study made clear that there is less to be gained from PROMIS in retrospective analysis than in prospective analysis. One of the lessons learnt from the Cameroon case was that an analysis along the lines of the categories that PROMIS provides would have helped manage the related development programme to better navigate relevant complexities in which it became stuck.

From early experiences with its application, I found that PROMIS, although providing a basis for thinking more critically and comprehensively about processes of scaling innovations, is not sufficient in itself to support decision making in relation to scaling initiatives. Chapter 6 should therefore be considered as an attempt to help popularise perspectives from PROMIS and make them accessible to a wider audience.

6. How can decision-making processes (including policymaking) benefit from the suggested methods and approaches as discussed in relation to the above five questions towards advancing what may be framed as responsible scaling practice?

As discussed in Chapter 1, developing ideas for improving the practice of scaling innovations is based on the assumption that this could and would help to address vulnerabilities and shortcomings of the scaling innovations approach, even though Chapter 2 presents some serious concerns about the approach as such. I am aware that ideologies, paradigms, and related systemic conditions will not change overnight. With all the defects in societal orientations and systems, it is important not to just stand on the side-line and comment, but also to contribute to smaller steps of change that can be addressed immediately (Pope Francis, 2015). With this in mind, I coined the concept of responsible scaling, much along the lines of ideas related to responsible innovation but treating scaling processes as a distinct dynamic deserving a dedicated focus. This still seems to be a useful way of framing a new way of approaching the idea and practice of scaling innovations for development and progress.

After the experiences with the application of PROMIS, it became clear that decision makers generally look for simpler (not so comprehensive) forms of guidance in relation to scaling initiatives – something that would also connect better to existing practice. This led to the conception of the idea of theories of scaling as a variation, or rather the specific application, of the idea of theories of change. This connects to the broad acquaintance with the theories of change concept, meaning that, with little explanation, many people can easily understand the essential purpose of theories of scaling. Chapter 6 captures the essentials of a booklet that I wrote earlier (Wigboldus, 2016) and further developed related ideas on the articulation of theories of change to enhance decision makers' readiness to engage with the scaling of innovations in responsible ways. Although the booklet contained practical outlines to help inform and articulate a theory of scaling, I also received feedback that, for some, it was still

rather conceptual and abstract, making it more difficult for some to access and use. I made a number of changes in the chapter in response to these comments but also kept the focus of the chapter as it stands for two reasons. First, my contribution in this thesis is first and foremost to enrich perspectives on scaling innovations and to point towards a direction for developing appropriate (analytical) frameworks to guide responsible practice. Second, I believe in the value of people struggling with perspectives and developing situation-specific approaches after being inspired in such ways. This connects to the suggested subject for further research discussed in section 7.4.3, potentially leading to the development of quite different approaches than I have put forward, and that is perfectly fine with me. This is in line with what Feenberg (1996) suggests and what I mentioned in section 2.6.2, that it is important to avail of several different critical approaches, depending on the case and not grounding ethics in just one or two perspectives or traditions of critique. I would hope that all kinds of approaches to responsible innovation and scaling will be developed, some which build on work as presented in this thesis, and some following quite different lines.

I consider the contribution of this thesis to be the introduction of a distinctly different perspective that diverges from the common instrumentalist ('how to') focus on scaling innovations. The frameworks presented are not definitive and require further development, refinement, and complementarity by different types of framework. The framework for responsible innovation (e.g. Stilgoe et al. 2013) is not a definitive framework either, but it does help to know what to be alert to. Similarly, a framework for responsible scaling is first and foremost about creating awareness about the many questions that need to be asked about the roots (motivation for), practice (strategy for), and fruits (effects of) scaling innovations. Related methodologies further develop this towards organised and structured ways of making sure relevant questions are being asked and related answers assessed. Besides and even before frameworks and methodologies, a positive disposition is needed towards what makes for responsible scaling: caring about being sufficiently broadly informed, having a healthy suspicion towards scaling rhetoric, checking motives and interests involved, awareness about short-term/long-term implications and other cross-scale concerns, creating transparency about conflicts of interest, acknowledging the political dimensions of scaling, facilitating, and informing dialogue and debate, and so on, while sustaining space for challenging (evaluating) related political choices through continuous assessment of implications and consequences.

A next step would be the further simplification of the message of this thesis for decision makers. Stilgoe et al. (2013) present just four dimensions of responsible innovation, and Gargana & McLean (2017) present just four guiding principles of

'scaling science'. That makes things more manageable and easier to work with, even if it cuts some corners in the process of simplification. I explore this further in 7.4.1.

7.3 Considering implications of the findings

In this thesis, I have connected to a number of scientific and societal debates. Chapter 3, for example, connects to scientific debates on the adoption of technologies. I have also connected to debates on the role of technology in society, on contested agronomy (Chapter 2), and on responsible innovation (Chapters 2, 3, 6), which I have suggested extending to responsible innovation and scaling. A key assertion made throughout this thesis is that climate change and other grand challenges are strongly related to scaling innovations. Furthermore, I challenge some of the approaches to addressing climate change through concepts such as climate-smart agriculture, arguing that climate-smart agriculture can be a way of greenwashing the scaling of technologies that are still part and parcel of business-as-usual (Chapter 2). The same argument holds for the idea of scaling food and nutrition security (FNS). Few will challenge the need to work towards FNS for all. However, in actual practice, the technologies and wider innovations that will be scaled in the name of achieving FNS may be related to highly contested things (e.g. GMOs, biofortified crops, and large-scale land acquisitions). Other debates connected to in this thesis are debates on intensification vs. diversification (Chapters 2, 3, 4). In the following, I briefly discuss the implications of this thesis for seven fields of research and practice.

7.3.1 Taking into account a variety of types of innovations and related implications for scaling

The wider implications of scaling innovations as discussed in this thesis relate closely to the variety in types of innovations. Scaling innovations relates to multifaceted dimensions and dynamics (as discussed in Chapter 3) and this is because innovation is not about a singular process either. The focus of common perspectives on both innovation and scaling tends to be on the technical and technological, whereas it more often than not relates to a range of different types of innovation. Sartas et al. (2017) developed a method to unpack this in what they call an innovation package. The theory of modal aspects, as used throughout this thesis, is useful for exploring such variety in types of innovation (Table 7.1). This type of overview can be useful in identifying the nature of pertinent innovation processes and the implications of associated scaling processes. Technical innovations interact with the other types of innovation in two ways: the path for their introduction can be paved through institutional innovation, and they themselves can be a way of paving the way for institutional innovation. Working with a more varied perspective, innovation may help address concerns raised by Blok & Lemmens (2015) regarding the need for a "radical transformation of the concept of innovation".

Table 7.1: Using the theory of modal aspects to identify different types of (institutional) innovation (adapted from Wigboldus, 2016b)

Types of innovation	What it is about	Typical example
Biological innovation	Innovation of biological options and opportunities	Hybridising a new crop variety; GMOs
Analytical innovation	Innovation of analytical and sense-making frameworks and models	Working with big data
Socio-ecological innovation	Innovation of human–environment interaction	Permaculture
Technical innovation	Innovation of physical options and opportunities	Creating a new device or tool (techniques)
Socio-technical innovation	Innovation of human–technology interaction	Automation of production processes
Cultural innovation	Innovation of (non-formal) institutions	Change in Sinterklaas celebrations in the Netherlands
Lingual innovation	Innovation in use of language and symbols	Use of English as medium in non-English speaking countries
Socio-organisational innovation	Innovation of organisational arrangements	Open office space; transdisciplinary research
Economic innovation	Innovation of economic/business models	Inclusive business models/value chains
Aesthetic innovation	Innovation in art, sports, etc.	New forms of abstract art
Political innovation	Innovation in governance, policies, etc.	More citizen involvement through referenda
Juridical innovation	Innovation in legal frameworks, laws	Introduction of a citizen jury in Dutch courts
Ethical innovation	Innovation in ethical/normative frameworks	The introduction of corporate social responsibility; responsible research and innovation
Ideological innovation	Innovation in ideological frameworks, mind-sets, and paradigms	Change of scaling paradigm (Gargani & McLean, 2017)

The overview in Table 7.1 does not reflect a pro-innovation bias. Innovation as process and product often involves changes that are more or less appreciated and more or less contested. In this, it is also important to consider intangible, including socio-cultural, effects of scaling innovations – for example, processes of alienation (as a result of the introduction of technology) on which Marx focused (Archibald, 2009; Wendling, 2009) and others explored along different angles (e.g. Adibifar, 2016) and connected to concerns discussed in Chapter 2, such as the process of monoculturalisation and McDonaldisation. Different forms of alienation may be the result of societal change (to which the scaling of innovations contributes): from institutions, from the living environment, from culture, from leadership, from policy/decision-making processes (politics) (Buijs, 2011). This underscores the serious implications of common

reductionist thinking in both innovation processes and in related processes of scaling of innovations. We will discuss this further in 7.3.4.

7.3.2 Developing contextualised perspectives

This thesis, particularly in Chapter 3, pointed to the need to develop contextualised perspectives on scaling innovations. This also means that what makes for responsible scaling requires an understanding of the dynamics affected by scaling at different levels (or framed in a flat ontology: in different measures of clustering of practices). This is to nuance critical perspectives on e.g. monoculture (as discussed specifically in relation to rubber cultivation in Chapter 4). In principle, it is a good starting point to begin by asking what makes for responsible scaling at farm level. However, what would not be responsible at farm level if all farms would do the same can still be considered responsible in a wider landscape perspective when there is local specialisation. For example, some farmers may grow a crop as monoculture and neighbours grow other crops, or the fields border patches of forest. This means that responsible scaling cannot only be approached at farm level. The same logic may be applied at higher levels where even whole localities may grow a crop in monoculture and other parts of a country or region grow other crops (e.g. because of agro-ecological conditions). At some scale level, however, this becomes critical, and the point is to know within which range of scale levels appropriate balance and harmony can be sustained. International agendas, treaties, agreements, and policies shape conditions that affect how scaling happens at farm and locality level and are vice versa also affected. Climate change, for example, can be a more local phenomenon (e.g. see the case of Southwest China), but multiple local conditions together affect global conditions. This nuancing of perspectives on monoculture relates to the topic of the governance of scaling innovations (or governance for responsible scaling), which is further explored in the next section. This also underscores the value of landscape approaches, which allow for connecting stakeholders across scales and dimensions around a common concern in a common space (the landscape). It helps to create integrative perspectives that lead away from considering effects of scaling innovations in isolation from wider impact.

7.3.3 Addressing the fear of paralysis

As discussed in Chapter 2, there is something like a pro-scaling bias, and decision makers and policymakers alike tend to be interested only in the question of how to make innovations go to scale. In my own experience over the past few years, on first hearing, 'responsible scaling' sounds like an inconvenient perspective for many. It is often perceived as complicating matters. It is considered to slow down preparations for programmes and initiatives. At least, that is what some managers think. One of

them exclaimed upon hearing the term responsible scaling: "that will paralyse us; you can't consider everything!" In a documentary on corruption in a large Dutch company, the CEO was heard to exclaim in a telephone conversation with a whistle blower: "We can't consider all those moral questions – I have a company to run, for goodness sake!"

Such inclinations need to be addressed. On hearing the reasons for, and the practical implications of, a responsible scaling approach, the abovementioned manager actually recognised the value of such perspective and the next day included this in his speech. Schomberg (2013:78), in the context of debates on responsible research and innovation, argued that "ethics should not be seen as being only a constraint of technological advances. Incorporating ethical principles in the design process of technology can lead to well accepted technological advances". Gee (2013:662), in the context of debates on precautionary principles, stated that "mistakes will be made, surprises will occur. But if the quality of the scientific and stakeholder processes used to arrive at such decisions are sound, and the best of science is used, then living with the consequences of such decisions, both pleasant and unpleasant, will be more acceptable". In other words, it is important to show how responsible scaling can be an actionable approach that helps to improve practice and that it is not meant to be a form of obstruction.

7.3.4 Avoiding reductionist approaches

In this thesis, I have approached the idea and practice of scaling innovations for development and progress from a critical perspective. Not because this is the only right way to approach them, but because I observed a need to complement the generally positive picture of the role of scaling innovations with a more critical one to help develop more balanced views. In a number of places, I have made use of the theory of modal aspects as a way of developing such more balanced views. Reductionist thinking abounds and, in addressing one reductionism (e.g. capitalism), the tendency is to move to another one (e.g. eco-socialism). Only paying attention to critical implications of scaling innovations would be another reductionism (in this case aptly phrased as criticism). There is a reason for the human tendency towards reductionisms (such as materialism, scientism, and economism). Science has thrived on reduction for methodological reasons so as to delimit a field of research and practice. Resulting limitations became the reason for the interest in inter- and transdisciplinary research. As discussed in Chapter 2, there are also ideological and paradigmatic roots to these reductionisms. This has to do with worldviews, vested interests, and the ability to exert control (which is easier if one sphere of life has been made an absolute). Thinking about what makes for responsible innovation and scaling in such contexts makes one aware that this is not just about developing frameworks and guidance materials. Before that, at least three other things will need to be agreed

on to be able to work together towards responsible innovation and scaling: 1) what are the virtues (what is good and right to do in a general perspective on life); 2) are we in principle willing to pay the price to bring our practice (including lifestyle) into line with what is needed for responsible and just practice; and 3) what do we consider to be the break-off point (range) where practice moves from being responsible and just into what is not responsible and just?

Holistic perspectives need to be complemented with integrative visions for society in order to charge such perspectives with a sense of direction to guide decision-making processes towards *responsible* (innovation and) scaling. Chapter 2 identified the materialistic and technology focus of common visions that motivate the scaling of innovations. The same chapter discussed how broadly defined goals such as food security cannot be scaled (up) as such but will be translated into what can be scaled up, which are usually innovations, most notably technologies. The same argument holds for the broadly agreed visions for society of sustainability and resilience. Some challenge the very use of the term 'sustainability' because it is used for so many things and has lost some of its edge. That points to the importance of the Sustainable Development Goals (SDGs), which have translated the concept of sustainability into concrete goals, targets, and indicators. Some want to replace 'sustainability' with 'resilience' (Benson & Craig, 2014), but for that concept there is even less of an agreed frame of reference, whereas others criticise the way it is used to support a policy of business-as-usual (Joseph, 2013). This also relates to the need to connect fields of study, for example by connecting learning on processes of scaling in fields such as Ecology and Geography to the field of development studies. I return to this theme in section 7.4.2.

Integrative visions for society are needed to provide orientation in the process of deciding on what may be considered as responsible scaling of innovations. This will require continuous unpacking and debate of what makes for sustainability, what makes for resilience, and what makes for responsible behaviour. Some will argue that this involves mainly the development of technological options, whereas others will argue that it requires mainly improving conditions and that this inherently orientates society towards that which makes for sustainability and resilience, such as by maintaining and restoring diversity (e.g. Stirling, 2013) and/or by establishing justice (e.g. Goudzwaard & Bartholomew, 2017).

7.3.5 Addressing the governance of scaling innovations

In Chapter 6, I discussed the need for scaling-sensitive policymaking that defines the policy space for the multiple interacting processes of scaling innovations (:120). There is no way that we can expect all companies and all farmers to consider their work in a

wide perspective. At least within their own sphere of control and influence they should, but this needs to be embedded in a wider governance of scaling innovations that is capable of considering how different processes of scaling innovations would interact and interactively affect society and nature. Such governance will need to take place at different levels, from local to global. Here, we enter a field in which much is happening and which is part of many studies. The governance of scaling innovations is about activating holistic perspectives and integrative visions, about making choices regarding what to aim for and how to be in this together, as societal actors. Roundtables and multi-stakeholder platforms offer opportunities for shaping such governance in interactive ways to overcome the competition drive by agreeing to shared standards. This involves complexities of "handling the interactions between the many actors and institutions involved – governments, policymakers, businesses, entrepreneurs, scientists, civil society representatives, citizens and the media. Each comes to the debate with different and often conflicting knowledge, perceptions, interests and priorities; balancing these numerous and often antagonistic positions should be seen as a prelude to making decisions on those innovations that have broad societal implications" (Gee et al. 2013:671). This thesis highlights the importance of not just discussing innovations and their direct implications in such platforms and other governance spaces, but the need to also consider (potential) implications regarding particular innovations going to a particular scale level, and, even more importantly regarding interactions between a variety of scaling processes.

Padt et al. (2014) explore the perspective of scale-sensitive governance. Its focus is on environmental conditions, but in their last chapter, they explore ways forward, also looking beyond the environment. That may provide fertile ground for including the perspective of responsible scaling within a governance framework. Such perspective connects to ideas on adjusting to planetary boundaries (Häyhä et al. 2016; Raworth, 2017) and to the idea of economies of scale with a perspective on total cost accounting and pricing (Barg & Swanson, 2004; Kirwana, 2015). Another dimension relates to framing scales and scaling frames in relation to the governance of agriculture (van Lieshout, 2014).

Governing the scaling of innovations for social, economic, and environmental sustainability and resilience will involve changing orientations, because currently it is not part of common perspectives. Such reorientation will need to be along similar lines to what Gee et al. (2013) identified in relation to the focus of innovation processes:

- Correcting "the prioritisation of economic and financial capital over social, human and natural capitals through the broader application of the policy principles of

precaution, prevention and polluter-pays, and improved accounting systems across government and business";
- Broadening "the nature of evidence and public engagement in choices about crucial innovation pathways by balancing scientific efforts more towards dealing with complex, systemic challenges and unknowns and complementing this knowledge with lay, local and traditional knowledge";
- Building "greater adaptability and resilience in governance systems to deal with multiple systemic threats and surprises, through strengthening institutional structures and deploying information technologies in support of the concept of responsible information and dialogues" (adapted from Gee et al. 2013:672).

This may be complemented by Stirling's (2013) argument for working with contrasting governance strategies and for pursuing the deliberate diversity of contending technological trajectories (:31) and by doing so sustain and capitalise on different dimensions of what makes for sustainability (see also Stirling, 2009). Governance is about creating common ground, common perspectives, and concerted effort. However, this may turn into grand governance schemes that could become totalitarian in nature and co-opted by powermongers. A key challenge in governance is to support an appropriate balance between the need for autonomy and the need for concerted effort. This also relates to developed scenarios that lean either towards increased globalisation or towards regionalisation (Carpenter et al. 2005).

This connects to the idea of the sovereignty of societal spheres (sphere sovereignty), which is about preventing a particular level of governance from becoming an absolute, dictating what must be done in each societal sphere. Societal spheres include the individual and the community. This idea was put forward by Dutch statesman Abraham Kuyper (1837–1920). It acknowledges an intrinsic limit to what a state can decide and address (Baus, 2006). This idea has been developed in relation to the theory of aspects (see Chapters 2 and 3), where it implies that the flourishing of an individual, of a community, or of an entire society depends on different ways of functioning in the defined aspects of experienced reality and therefore cannot be reduced to each other (which Jochemsen, 2006, discusses in terms of normativity of practices). Totalitarian regimes, for example, reduce the individual to being only a member of a community (or nation). This points to a need to carefully consider implications of governance models.

The governance of scaling innovations is also about 'development investment'. As discussed in Chapter 2, donors and funders of development efforts may create (perverse) incentives for achieving impact at scale by requiring target-setting for adoptions of innovations. This moves the focus of management practice away from its intrinsic quality to the ability to claim successful scaling of innovations and translating

this into mostly financial-economic effects. It is important that donors and funders are aware of the paradigm, ideology, and rhetoric to which they are possibly unwittingly subscribing through their requirements regarding impact at scale. This also relates to the issue of the (attempted) speed of scaling. Programmes work with limited time frames. Scaling has to happen quickly. We are in a hurry. This does not allow for time to gradually let new products and practices find an appropriate place in ongoing systems and processes, nor for a related process of gradual reconfiguration. This urgency is often inspired mainly by funding timelines. So, some of the problems in scaling innovations may stem from such haste leading to a push for scaling. It then becomes a question of whether the urgency is because of a true desire to see positive impact happen for primary stakeholders, or whether it is because of a need to scale organisational success ('we met targets'), donor/funder success ('we achieved a good return on investment') or government success ('we made the difference').

7.3.6 Enriching perspectives on principles of responsible investments and value chains

A similar argument for the need to extend the perspective of responsible innovation to responsible innovation and scaling applies to the need to connect the perspective of responsible scaling to the implementation of principles of responsible (agricultural) investment[22] and value chains (de Adelhart Toorop et al. 2016; OECD/FAO, 2016). This involves questions concerning the way in which processes of scaling innovations interact with the principles. To take the first principle of responsible agricultural investment as an example, how could processes of scaling innovations affect the extent to which existing rights to land and associated natural resources are recognised and respected? This requires an ability to anticipate how the scaling of particular innovations could interact with land rights. That this question is not too far-fetched is revealed in the many critiques on large-scale land acquisitions (e.g. Fairhead et al. 2012; Matondi et al. 2011; Schoneveld, 2017). It also connects to wider critiques of the principles of responsible agricultural investment (e.g. Castellanelli, 2017). This points to the need to inform the practice of principles of responsible agricultural investment by a good understanding of how scale and scaling plays out in this.

7.3.7 Broader implications of scaling innovations

In this thesis, I did not really discuss the connection to debates on scaling information technologies. My focus has been on the idea and practice of scaling agricultural innovations; but the core argument of this thesis applies equally there. Increasingly, information technologies are creating a basis of influence and control by large

[22] See https://www.unpri.org/ and https://responsibleagroinvestment.org/ for an overview a various versions of such principles.

companies and governments. Citizens have helped a wide array of information technologies to go to scale by participating in their use (internet, social media, and so on) only to find out that, by doing so, they are losing many forms of privacy and protection against abuse of information about themselves and what they are interested in. Yet, people appear to be willing to accept loss of freedom if they can be part of the latest innovations. The shocking implications are best illustrated by the recent development of the social credit system in China[23]. Perhaps less shocking, but equally revealing, are implications of scaling the use of social media such as Facebook[24]. This demonstrates how the widespread desire for means that provide more comfort and information has come back to bite the users through increased dependency and vulnerability in other areas of life. In the context of information technologies, the new adage of large companies and certain governments appears to be 'Scale and Rule'. It is not strange that many start to see a situation emerging that is reminiscent of George Orwell's *1984*.

China is currently the country par excellence for embracing the scaling innovations for development and progress approach. This affects conditions not just in China, but also everywhere in the world where China is investing. Is this a typical Chinese approach, or is China copying a typically Western approach to progress and development? China (and consequently large parts of the world) would benefit from a responsible (innovation and) scaling approach. I realise that it will require a responsible scaling approach *with Chinese characteristics*. If China embraced such an approach, it could be setting a new trend with a large following. Related cultural-historical research as well as active development as China and with China towards new ways of engaging with the scaling of innovations in more sustainable ways (socially, economically, and environmentally) would be felicitous. This could also be a way of engaging China in discussions on principles of responsible (agricultural) investment. Granted, this is not an easy subject matter, but it would be in line with the change in management principles of 'change what needs to be changed, not what is easy to change'.

It all goes to show that scaling innovations relates to processes that have the potential to deeply alter the fabric of society, and this demands a critical attitude and requires better foresight than is commonly practised. Many (French) philosophers and social critics have played the role of modern-day prophets, warning society of implications that at the time of their prophecies still seemed insignificant. As I discuss later in this chapter, it is time to better connect different fields of knowledge and wisdom, and not

[23] http://www.wired.co.uk/article/chinese-government-social-credit-score-privacy-invasion
[24] https://www.theguardian.com/technology/2017/dec/11/facebook-former-executive-ripping-society-apart; https://washingtonmonthly.com/magazine/january-february-march-2018/how-to-fix-facebook-before-it-fixes-us/

to let science resort to a role of merely supporting dominant growth-oriented business models.

7.4 Further research

The above discussion of implications of the findings presented in this thesis already talks to wider areas of research to which this thesis connects and perhaps contributes.

In this section, I list three specific research areas that I consider require specific attention as they are not yet part of ongoing research (as far as I know). The subjects of the governance of scaling innovations and of extending responsible innovation to responsible innovation and scaling would also have featured on this list, but I consider these to involve smaller steps because of the extensive work already done in the field of the governance of scale and of responsible (research) and innovation.

7.4.1 From theory to practice

Earlier in this chapter, I identified a limitation of this thesis in relation to practical applicability. There are many critical considerations and, yes, responsible scaling is needed. But how exactly can this be translated into helpful guidance for design and management processes and practice? I worked along those lines, but I realise that my tendency is still to keep things rather conceptual. Without such translation to guidance of operational processes, the idea of responsible scaling will not take off. This connects to the same challenges faced by the perspective of responsible research and innovation. Further research and development towards clear and not too difficult methods, as well as actionable approaches, will require a team effort by team members who possess both conceptual skills and communicative skills as well as broad experience with how things work on the ground. The ability to translate complex considerations into simple (not simplistic) guidance is key. This involves addressing questions regarding what responsible scaling means for research practice, for government practice, for NGO practice, for private sector practice, for donor practice. As noted earlier, shorter lists of key principles may be the way to go. Such principles can then later be further unpacked, but they provide a manageable overview so that people do not get lost in that process of unpacking. It may resemble the definition of principles of responsible (agricultural) investment. I have focused much on analytical approaches in this thesis; but defining principles may in many cases be more effective in getting the core messages on responsible scaling across. This is a key area for further research and development. I would like to offer one hypothesis to be further tested: Individual and group capabilities and competences, including related social and moral/ethical capital, are the most important factors determining the ability to engage effectively and responsibly with processes of scaling innovations, more important than

analytical and methodological approaches. If this hypothesis were confirmed, it would mean that more attention should be paid to a different type of education, training, and character formation than that which focuses on *knowledge*. In the world of science, this connects to ideas on learning for sustainability (e.g. König & Ravetz, 2017; Wals & Corcoran, 2012) but would also need to connect to other domains of knowledge and wisdom, in line with the transdisciplinary approach as depicted in Figure 7.4.

7.4.2 Towards a science of scaling and beyond

New perspectives on scaling processes have arisen recently, perspectives that acknowledge the need to carefully consider options in scaling innovations. Already in 2011, Simons et al. developed a perspective on 'the 'science of scaling up'. More recently, Gargani & McLean (2017) developed a perspective on 'scaling science'[25] in which they define four guiding principles related to, what they call, a new scaling paradigm: moral justification, inclusive coordination, optimal scale, and dynamic evaluation. There is a clear overlap with the idea of responsible scaling that I have presented. They also discuss the concept of a 'scaling theory of change', which closely resembles the theory of scaling that I have presented. Sartas et al. (2017) are also working on a 'science of scaling' along the lines of a scaling readiness (assessment) approach. This demonstrates that developing new perspectives on, and approaches to, scaling innovations (a new paradigm) is something in which there is broad interest. As noted earlier, there are, however, other disciplines that have been using the concept of scale and scaling intensively for a long time already (e.g. in Ecology and Geography). Wu and Li (2006) also proposed working towards 'scaling science'. It would be good if there were not going to be different types of scaling science or science of scaling in different domains of research and practice. It is exciting that the International Development Research Centre (IDRC) is putting some serious effort into research critically reviewing the impact of scaling innovations. The IDRC is, unfortunately, still quite an exception to the scaling focus of most groups in the development sector, who still focus on 'how to make scaling happen'. If there is going to be an established science of scaling, this needs to then also connect to scaling processes in nature such as scaling laws, tipping points, and fractals. This involves understanding causal relations between different scaling phenomena (e.g. West, 2017). Fractals are patterns that repeat themselves on different scales and were discovered and theorised in the famous book, *The Fractal Geometry of Nature* (Mandelbrot, 1982). As noted in Chapter 1, research in that field may hold important insights that can be applied in the context of development and that would make a science of scaling more complete.

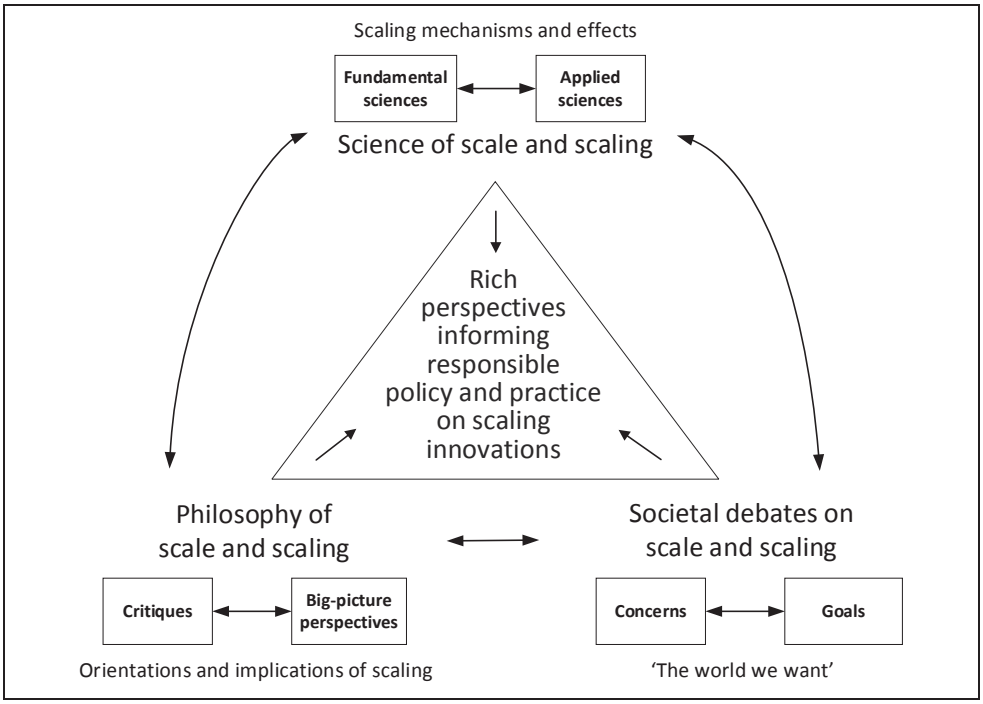
[25] Developed at IDRC: https://www.idrc.ca/en/stories/scaling-science

But I would actually propose to take one step further. Besides the positive news of the above examples of taking scaling processes more seriously, I am also concerned about this idea of a science of scaling. What I have tried to show in this thesis is that scaling innovations relates to scientific questions as well as to societal questions and concerns. Science cannot address challenges relating to scaling innovations on its own. For example, trade-off analysis is not a purely scientific endeavour, although science plays an important role in making sure that this is done on the basis of reliable and accurate knowledge and information. It is not just a science of scaling that is needed, but also a philosophy of scaling and an ethics of scaling. As discussed in Chapter 3, scaling processes require a transdisciplinary approach and need to listen to voices from society, including political choices. A science of scaling may still resort to addressing the common instrumentalist question of 'how to make this innovation go to scale' (through scaling mechanisms). I would argue for a need to think about three complementary angles that interactively inform policy and practice: a *science of scale and scaling* for endeavours such as Wu & Li (2006) propose, which are more strictly about understanding concepts of scale and scaling from a variety of disciplinary angles, 2) a *philosophy of scale and scaling*, which addresses wider questions about implications of scale and scaling, and 3) *societal and political debates on scale and scaling*, which involve transdisciplinary and multi-stakeholder interactions (Figure 7.4). The centre of Figure 7.4 is also about (responsible) governance of scale and scaling innovations.

Such an approach would help to address the need for conceptual clarity on concepts of scale and scaling. Frake & Messina (2018) propose separating the noun scale from the verb to scale in order to be able to arrive at a common ontology of scaling up. In this however, the 'common' is limited to the context of development theory and practice. I would argue that we need to go a step further and not fix this within just one scientific or development domain. That will require systematic analysis and development of scaling concepts across disciplines and fields of application. It will help address confusing adjectives used in relation to scaling such as 'vertical' scaling and 'adaptive' scaling, and even the popular scaling 'out'. Such framing does not help us to understand what exactly such scaling is about. Scaling means that something moves up or down a particular scale. I would therefore still argue for the simple approach of defining the scales involved and what movements (up or down) a particular (aspired) change implies. Also, as discussed in Chapters 1 and 2, the very term scaling may be used for political reasons, as it conveys a sense of significance and really being on to something. Getting to grips with a common (in a broad sense) ontology of scale and scaling would benefit from the perspective as presented in Figure 7.4. At the same time, I would argue for the reconsideration of the entire utility and appropriateness of the term scaling in the context of the wider application and use of

innovations. Given all that needs to be unpacked regarding what actually goes to scale as discussed in this thesis, and, given the misleading strong connotation of inherently related progress and development, I would suggest considering its replacement with verbs that better reflect pertinent intentions and implications. The term and related conceptualisations should perhaps be limited to use in science only.

Figure 7.4: Towards a transdisciplinary perspective on scale and scaling



This perspective may also help in getting to grips with questions regarding when something can be considered as responsible scaling. Stilgoe et al. (2013) have opted to develop a framework for responsible innovation along the lines of an epistemological focus rather than an ontological focus in order to move away from hot debates on what could be considered a responsible innovation and what not, which could lead to endless discussions (Guston, 2015), discussions which may not always help to move forward toward responsible practice. Further developing frameworks to guide decision making towards responsible scaling of innovations will need to come to terms with the many ways in which responsibility may be interpreted. Much work has been done in the field of understanding conceptual and practical implications of the concept of responsibility (e.g. Van de Poel & Fahlquist, 2012; Vincent, 2011), where responsibility is discussed in terms of capacity, virtue, role (authority), causation (causal relationship), outcome, and liability. This leads to many different kinds of questions regarding responsibility, and out of these questions even more disputes about responsibility can emerge.

How could the perspective sketched in Figure 7.4 be applied in practice? This relates to the common challenges faced by transdisciplinary collaboration. Science tends to be organised along the lines of different disciplines, philosophy along the lines of different schools, and society along the lines of different political perspectives. This means that moving towards such a transdisciplinary approach will need to go step by step: e.g. by including perspectives from philosophy and society in conferences on scaling (agricultural) innovations. Connecting perspectives on responsible scaling to existing arenas of debate and development, such as responsible innovation and responsible (agricultural) investment, would help to prevent the scattering of a variety of critical perspectives.

7.4.3 Understanding individual dispositions towards responsible practice

While I was supporting research-for-development projects, I often engaged in discussions on what makes the difference in terms of the readiness or preparedness of a project to engage effectively and responsibly with processes of scaling innovations. Some argued that better (assessment) methodologies would make the difference. Practitioners often agreed, however, that much depends on individual and group (organisation) competencies (especially soft skills) and areas of expertise, including abilities to forge and facilitate collaborative action. In the end, it is individuals who make decisions based on a variety of motivations. Systems are important, yes, institutions are important, yes, but, within such contexts, individuals make choices and develop strategies (including on how to change systems or institutions) (Long, 2001). It is important to understand how this plays out in specific contexts in which particular ideas and practices of scaling innovations are prevalent. I have paid only limited attention to this in this thesis.

In the booklet that I wrote on theories of scaling (Wigboldus, 2016), I use a metaphor to express the need for discourse involving different perspectives on development and progress, which, through interaction and not mere compromise[26], find appropriate ways forward. It is a picture of two persons on a tandem bicycle arriving at the summit of a hill. The person on the front seat exclaims: "if I had not been pedalling so hard, we would have never made it", whereupon the person on the back seat responds: "and if I had not been braking so hard, we would have gone backwards just as fast". It is, of course, a joke; but there is a lesson in it. The story could also have been framed as the tandem bicycle going downhill with a sharp turn coming up next to a deep ravine (to prevent creating the idea that the one braking is doing nothing but slowing down the pace). Psychology has taught us about differences in characters and personalities that have to do not with positive or negative judgements, but rather with different

[26] Along the lines of the Proverb: "as iron sharpens iron, so one person sharpens another", Proverbs 27:17, the Bible.

inclinations, different orientations, different mental filters, and different types of drives (e.g. see the Belbin® team roles or Kendall® Life Languages). Some people jump on every opportunity (the doers) and others first wait to see which way the wind blows (the thinkers). This translates into some people being inclined to embrace each and every new technology, not really worrying about longer-term effects of using them (at scale), whereas others will be inclined to ask lots of critical questions. Teams at all levels, from small groups to international agencies, deal with related implications for variations in what is considered development or progress. Some of it originates from differences in worldviews (e.g. Enlightenment vs. Romanticism) and religious persuasion, some of it relates to differences in cultural backgrounds, some of it relates to differences in socio-economic conditions, and some of it relates to differences in personality and type of character. In considerations about what makes for responsible scaling of innovations, the challenge is to be able to distinguish between what relates to such differences (which need to be accommodated), and what relates to fundamentally irresponsible and unjust practices irrespective of such differences.

Taking this a step deeper, Le Menestrel & Rode (2013:613) discuss causes of particular dispositions towards risks related to innovations and technologies in particular. "A large body of psychological and 'behavioural economics' research is dedicated to the 'bounded rationality' of risk perception and decision-making under uncertainty (Kahneman & Tversky, 1982). Psychological theories of judgement and decision making provide a number of explanations for human failure to adequately process risks and probabilistic". As a result, people often focus on benefits that a new product or practice promises, without considering wider implications. Le Menestrel & Rode (2013: 614) also discuss other types of dispositions towards risks such as ethical blindness (Palazzo et al. 2013), ethical biases (Banaji et al. 2003), and bounded ethicality (Gino et al. 2008): "A prominent and widely studied phenomenon is the 'self-serving bias', which refers to people's general tendency to interpret ambiguous situations in their self-interest (Babcock & Loewenstein, 1997). For decisions where self-interest conflicts with ethics, this implies that people engage in self-deception that helps them reinterpret or disguise the fact that acting in their self-interest violates ethical principles. Such phenomena can be largely unconscious, and psychologists tend to relate them to the reduction of cognitive dissonance (Festinger, 1957) that stems from conflicting goals such as making profit and acting ethically".

A number of research questions may be derived from the above. What shapes individual's dispositions towards what makes for responsible practice? As noted in relation to responsible innovation, few would be against the general idea of responsible practice (Guston, 2015). So then what motivates individuals to translate such general idea into concrete practice. Scaling innovations involves dealing with complexity and long-term implications. As noted earlier in this chapter, some feel it

would bring paralysis if they would need to act from a related integrative perspective. What shapes such fears and could they be addressed? Would this possibly link to what some have framed as "sustainability education" (Corcoran et al. 2017) which also seeks to address the question of what makes for responsible behaviour?

At another level and related to the earlier reflections on scaling innovations in China, there are questions regarding cultural dispositions towards scaling innovations for development and progress, in terms both of nation-related cultures and of sub-cultures within nations. Is the idea of scaling innovations for development and progress is a typically Western idea that has spread? This relates to my discussion in Chapter 2 on an ideology of scaling innovations for development and progress. Is this a widespread ideology? Another question would then relate to the spreading of this idea (and ideology) across cultures.

This is a fascinating field of study and a much-needed complement to a focus on developing analytical and managerial frameworks and methodologies.

7.5 Conclusions

I started this thesis with the observation that the idea and practice of scaling innovations is generally embraced as a key mechanism towards achieving progress and development. It is also commonly based on an instrumentalist perspective that assumes the suitability of promising innovations (technologies) for wider application and focuses almost exclusively on the question of 'how to make scaling happen'. From initial literature research, I found this perspective in need of critical reflection because of the seriousness of potential implications. I also found that such critical reflection is not common and has only recently started to appear. The research process of rethinking the idea and practice of scaling innovation for development and progress (i.e. this thesis) not only confirmed the need for critical reflection, but also demonstrated the centrality of processes of scaling innovations to shaping society. This includes demonstrating the ideological roots of the generally highly held expectations about the 'massive' scaling of innovations as providing the 'solutions' to society's grand challenges and the simultaneous and generally neglected consideration of negative impact at scale through that very same process of scaling innovations.

The development of new (analytical) frameworks (Chapters 3 and 6) and their application in case studies (Chapters 4 and 5) demonstrated the value of, and the need for, integrative and holistic perspectives in understanding what is involved in scaling processes. By doing so, these chapters highlighted the fact that scaling processes are not confined to single domains of change. For example, changes in agricultural practices (at scale) often have an impact on environmental, social, and cultural

domains of change. And vice versa, the possibility of changing agricultural practices (at scale) is often influenced by social, cultural, and wider institutional conditions.

The effects of scaling innovations have been the focus of many debates, from debates on technologisation to globalisation and the causes of climate change. I have added only a few new observations to those debates. However, this thesis demonstrates the connection between the idea and practice of scaling innovations and those societal and scientific debates. So far, these have tended to be separate areas of thinking and practice. I also explored more widely the need to connect domains of knowledge and wisdom. It is a pity that deep insights emerging from studies on scale and scaling in, for example, Ecology and Geography tend to remain largely unexplored in terms of implications for understanding processes of scaling innovations and their implications. That needs to change. However, rather than aiming for a new science of scaling, I would argue for a richer way of informing policy and practice in relation to scaling innovations (see Figure 7.4). At the same time, rather than developing a separate field of study on, and practice of, responsible scaling, I think it should enrich perspectives on responsible research and innovation and become part of ongoing developments in that field.

Research and development funders and donors have a key role to play in rethinking the practice and implications of scaling innovations. Their proposal and implementation requirements have often pushed research and development organisations into a tunnel focus on achieving scale (quantity before quality) and have contributed significantly to the common instrumentalist focus of scaling initiatives. As a result, even the SDGs may become perverse incentives for mere scaling rhetoric about achieving certain numbers. They need to stay connected to their deeper purpose, which is essentially about what makes for inclusive human flourishing and environmental stewardship.

I consider the main contribution of this thesis to be the introduction of a distinctly different perspective which diverts from the common instrumentalist ('how to') focus on scaling innovations. Frameworks presented are not definitive and require further development, refinement and complementing by different types of frameworks. The framework for responsible innovation (e.g. Stilgoe et al. 2013) is also not a definitive framework, but does help to know what to be alert to. Similarly, a framework for responsible scaling should first and foremost help create awareness about critical questions that need to be asked about the roots (motivation for), practice (strategy for), and fruits (effects of) scaling innovations. Related methodologies can help further develop this towards systematic and structured ways of making sure pertinent questions are asked and that related answers are interpreted and translated towards implications for decision making and policy development. Such frameworks and

methodologies only help if they are complemented by a positive disposition towards what makes for responsible scaling: caring for being sufficiently-broad informed, having a healthy suspicion towards scaling rhetoric, checking motives and interests involved, being aware about short-term/long-term implications and other cross-scale concerns, creating transparency about conflicts in interests and related power differentials, acknowledging the political dimensions of scaling, facilitating and informing dialogue and debate, and all the while sustaining space for challenging (evaluating) decision making through continuous assessment of implications and consequences.

This thesis, though addressing a broad subject area, has still been limited in scope. There are many practical questions left to be answered to prevent this from remaining a mere theoretical exercise, and this includes the need for more field research and testing of hypotheses related to what makes for responsible innovation and scaling. A team effort involving a variety of perspectives and fields of expertise is required to take this to a next level. I have identified and explored a direction for how to think about scaling innovations in new ways and have sketched initial ways of applying this in practice. Considering the research capacity that has taken on the perspective of responsible research and innovation, and the emerging new perspectives on scaling innovations (such as discussed earlier in this chapter), I trust that what this thesis has contributed will be a building block in further research and development in relation to the idea and practice of scaling innovations.

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Summary

This thesis presents the case for the need to approach processes of scaling innovations for the purpose of achieving development and progress more critically than is commonly done. Such includes a need to consider related complexities and potentially negative implications from a more holistic perspective. The thesis discusses related concerns as well as opportunities for developing a practice of responsible scaling of innovations.

Chapter 1 presents the backdrop for the research to which this thesis pertains: The term scaling (up) has become increasingly popular over the past three decades in the context of development initiatives and related investment proposals. The object of such scaling (up) is often generalised as innovations, which include (new) technologies, practices (and habits), policies (and wider institutions), and projects. Such innovations are generally considered to be a response to societal challenges. The term is therefore used widely in various (scientific) contexts involving different interpretations and applications. This thesis focuses on how it features in the context of initiatives that are meant to contribute to what is generally framed as 'development' and 'progress', including to related development goals such as the Sustainable Development Goals (SDGs). Within this focus, particular attention is paid to processes of agricultural development and innovation. Scaling innovations is generally viewed as a critical mechanism to achieve development and progress and consequently is rarely criticised, and certainly not the subject of hot debate. Questions generally focus on how to scale innovations. An initial literature review pointed to a range of critical issues related to the implications of scaling innovations. This resulted in the definition of a number of key research questions that this thesis addresses, including: What kind of thinking and philosophy underpins the idea and practice of scaling innovations for development and progress? Are the high expectations of this mechanism for development and progress warranted? What are the related theories of change? Successes have been claimed, but how serious are potential negative implications? What are the relevant areas of contention? Is there a need to apply guiding frameworks along similar lines as are adopted in relation to responsible innovation? To what extent are development actors aware of how scaling (up) processes sit in a wider context of other development processes and other perspectives on how change happens and/or is preferred to happen? What evaluative frameworks are used to assess the long-term outcomes of scaling innovations? These questions were grouped in relation to two different angles: 1) the roots and fruits of scaling innovations for progress and devleopment, and 2) the practice of doing so.

Following up on the above research questions, Chapter 2 focuses on questions related to the ideological roots of the idea and practice of scaling (up), considering implications and ways in which to move towards an ethics of scaling innovations along similar lines as already developed for technology and for innovation. Chapter 3 explores possibilities for devising a framework to guide the development of more comprehensive and systemic perspectives on scaling agricultural innovations to remedy the narrow scope of common perspectives on the same. Chapter 4 applies systemic perspectives from Chapter 3 to the case of scaling green rubber in Southwest China; this pertains to a more prospective analysis of what to consider in developing appropriate scaling strategies. Chapter 5 applies systemic perspectives from Chapter 3 to the case of cocoa farmer field schools in Cameroon with the purpose of finding out how much this adds in terms of understanding relevant factors that play a role in scaling initiatives; this pertains to a retrospective analysis. Chapter 6 further explores opportunities for developing frameworks to guide scaling initiatives towards responsible scaling practice. The focus is on applying the concept of theories of change to a perspective of *theories of scaling* with the purpose of using this perspective to better inform scaling initiatives and related policymaking. Chapter 7 revisits the research questions and the defined purpose of this study, considering what the various chapters have addressed in that regard, and touching on relevant other topic areas that could not be addressed (fully) in this thesis. This leads to a number of suggestions for further research and development along similar lines as explored in this thesis.

Chapter 2 traces the use of the concept of scaling in history and identifies scaling processes as being at the heart of common societal trends, including industrialisation and globalisation. The chapter considers three inherent implications of processes of scaling innovations that characterise the nature of such processes: the technology orientation, the model orientation, and associated shifts in natural and social conditions. Core narratives that motivate the idea of scaling of innovations for development are characterised in terms of rhetoric, paradigm, and ideology. This is followed by a discussion of the areas in which the scaling innovations for development and progress approach should be addressed more critically and how this could be done. Moving from critique to counsel, three fields are suggested for translating critique on the scaling innovations for development and progress approach into guidance for management and policy development. The chapter does not provide a full story of implications and complications of scaling innovations for development and progress, but rather identifies a much-needed direction in which to go to make related thinking and practice the object of critical discussion and debate along similar lines as debates on technology and innovation. Such direction is further specified as the need to improve understanding about what scaling innovations implies and involves, to develop matching normative perspectives to inform and guide scaling

ambitions and related change initiatives, and to broaden the idea and concept of responsible innovation towards a perspective on responsible innovation and scaling.

Chapter 3 follows up on that last theme by discussing an analytical approach to responsible scaling. Agricultural production involves the scaling of agricultural innovations such as disease-resistant and drought-tolerant maize varieties, zero-tillage techniques, permaculture cultivation practices based on perennial crops, and automated milking systems. Scaling agricultural innovations should take into account complex interactions between biophysical, social, economic, and institutional factors. Actual methods of scaling are rather empirical and based on the premise of 'find out what works in one place and do more of the same in another place'. These methods thus do not sufficiently take into account complex realities beyond the concepts of innovation transfer, dissemination, diffusion, and adoption. Consequently, scaling initiatives often do not produce the desired effect. They may also produce undesirable effects in the form of negative spill-overs or unanticipated side effects such as environmental degradation, bad labour conditions for farm workers, and farming communities' loss of control over access to genetic resources. Therefore, here, we conceptualise scaling processes as an integral part of a systemic approach to innovation, to anticipate the possible consequences of scaling efforts. We propose a method that connects the heuristic framework of the multi-level perspective (MLP) on socio-technical transitions to a philosophical modal aspects framework, with the objective of elucidating the connectedness between technologies, processes, and practices. The resultant framework, the PRactice-Oriented Multi-level perspective on Innovation and Scaling (PROMIS), can inform research and policymakers on the complex dynamics involved in scaling. This is illustrated in relation to three cases in which the framework was applied: scaling agro-ecological practices in Nicaragua, farmer field schools on cocoa cultivation in Cameroon, and green rubber cultivation in Southwest China.

Chapter 4 discusses the case of green rubber in Southwest China in more detail. The rubber boom across much of Southeast Asia has led to environmental destruction, and the resultant crash in the price of rubber has destabilised livelihoods. We investigated the necessary factors required to enable a transition towards a more sustainable model for rubber cultivation in Southwest China (i.e. the 'greening' of rubber cultivation), using the framework for the integrative study of multiple aspects in complex land use issues (PROMIS) developed in Chapter 3. We present findings from stakeholder interviews and a stakeholder workshop and discuss their relevance within and beyond Southwest China. The current focus of researchers and development practitioners tends to be on finding technical solutions to address unsustainable rubber cultivation practices. However, stakeholder consultations revealed that the key barriers were

more social: low levels of trust, low levels of knowledge exchange between stakeholder groups, and fragmented visions about the future of the landscape. It is very important to continue the economic prosperity initially brought by rubber, but, without improved communication between government and researchers and smallholder farmers, this will be very difficult to achieve. A wider landscape perspective is needed to address issues in rubber cultivation to avoid repeating the same problems of cash crop boom and bust experienced with other crops, most notably bananas. We conclude that more effort should be put into developing mechanisms that integrate technical knowledge, enhance social relationships, and present a forum for reconciling – or at least acknowledging – the differing needs, knowledge, and objectives of different groups, and transcending the power dynamics between smallholder farmers and government and researchers.

Chapter 5 discusses the case of cocoa farmer field schools in Cameroon in more detail. The farmer field school (FFS) concept has been widely adopted, and such schools have the reputation of strengthening farmers' capacity to innovate. Although their impact has been studied widely, what is involved in their scaling and in their becoming an integral part of agricultural innovation systems has been studied much less. In the case of the Sustainable Tree Crops Programme in Cameroon, we investigate how a public–private partnership did not lead to satisfactory widespread scaling in the cocoa innovation system. We build a detailed understanding of the key dimensions and dynamics involved and the wider lessons that might be learned regarding complex scaling processes in the context of agricultural innovation systems. Original interview data and document analysis inform the case study. A specific analytical approach was used to structure the broad-based exploration of the qualitative dataset. We conclude that scaling and institutionalisation outcomes were impeded by: the lack of an adaptive approach to scaling the FFS curriculum, limited investments and limited genuine buy-in by extension actors, a failure to adapt the management approach between the pilot and the scaling phase, and the lack of strategic competencies to guide the process. Our findings support suggestions from recent literature that pilots need to be translated and adapted in light of specific contextual and institutional conditions, rather than approached as a linear rolling-out process. These findings are relevant for the further spread of similar approaches commonly involved in multi-stakeholder scaling processes, such as innovation platforms.

Chapter 6 discusses a framework to guide decision-making processes to make scale work for sustainable development. Theories of change are meant to support the strategic design and guidance of agricultural research and innovation in light of an aspired contribution to impact at scale, i.e. societal objectives such as the SDGs. How scaling beyond the immediate research and innovation context is expected to happen is, however, often scantly elaborated in theories of change. The question of 'how

scaling could happen' (i.e. a theory of scaling) tends to remain a black box of unarticulated assumptions. Similarly, policymakers often lack a governance sense-making framework to consider the appropriateness of a multitude of scaling initiatives in light of societal goals. Recent studies have drawn attention to the fact that scaling processes involve greater complexity than is generally taken into account. This chapter addresses this situation by unpacking what is in that black box and translating this into a guidance framework along the lines of a theory of scaling as a dedicated component of a wider theory of change. This is meant to support researchers, management decision makers, and policymakers in engaging more effectively and responsibly with scaling initiatives. Apart from that framework, a suggestion is made to develop specific expertise in the field of scaling processes.

Chapter 7 reflects on the findings from the earlier chapters, considering the general purpose of this thesis, which is to rethink the idea and practice of scaling innovations for development and progress. It observes that the popularity of scaling innovations for development and progress_has increased further in the context of international development and certainly also in the context of agricultural (research for) development.

The combined learning on the roots and fruits of scaling innovations (as explored in particular in Chapters 2 and 3) points to possibilities for developing a perspective on, and a practice of, responsible innovation *and scaling*. First of all, together they point out why ambitions to scale innovations need to move towards clearer perspectives on what makes for responsible practice – notably because of the inherent potential to create distortions due to changes in proportions and ratios – and related reductionisms, because of the limitations in the common linear approaches associated with scaling innovations and because of the misguided pro-scaling bias. Secondly, such perspective and related practice help to take processes of scaling innovations and their implications more seriously along a number of lines:

- By addressing logical fallacies and reductionisms involved;
- By acknowledging ideologically motivated ambitions;
- By connecting the idea of scaling innovations to relevant wider societal concerns and debates;
- By extending the concept of responsible innovation, which allows for building on what has already been developed along those lines while offering complementary perspectives on scaling processes;
- By offering ways of operationalising principles of responsible (agricultural) investment by linking such principles to the practice of scaling innovations, which features prominently in such investments;
- By offering ways of operationalising concepts such as ecosystem tipping points and planetary boundaries by linking such perspectives to the practice

of scaling innovations, which contribute significantly to concerns about a safe operating space for humanity;
- By offering ways of extending the concept of scale-sensitive governance to the governance of scaling innovations.

The experiences with the application of an analytical framework (discussed in Chapter 3) were discussed in Chapters 4 and 5. They led to a realisation that something simpler and perhaps more intuitive would be needed to guide decision making in relation to scaling initiatives – something that would connect to existing practice. This led to the conception of the idea of 'theories of scaling' as a variation, or rather a specific application, of the idea of 'theories of change', as discussed in Chapter 6. This connects to the broad acquaintance with the concept of theories of change, which means that, with little explanation, many people can easily understand the essential purpose of theories of scaling.

Chapter 7 also further reiterates the essential purpose of this thesis, which is to enrich perspectives on scaling innovations, to point to a direction for developing appropriate (analytical) frameworks and to processes for guiding towards responsible scaling practice. For some, such a perspective may be inconvenient, because they are interested mainly in the 'how to make scaling happen' question. The chapter argues for making use of several different critical approaches, leading to the development of different types of approaches to responsible innovation and scaling, some of which build on work as presented in this thesis, and some following quite different lines. The chapter closes by suggesting a number of ways in which the idea and practice of responsible scaling of innovations could be further developed. This includes topics such as the governance of responsible scaling of innovations, the use of integrated perspectives and practices (e.g. taking landscape approaches as an example), and the development of a trans-disciplinary approach to scale and scaling innovations.

About the author

Seerp Wigboldus (1964) was born and raised in Wageningen where his father was assistant professor of Tropical Agrarian History at Wageningen University. As his father often shared about his research at the kitchen table – whether there was a willing ear or not – his children automatically picked up a sense of what historical research was (and should be) about, including an interest in exotic places that were difficult to find on the world map. Much of his research was about spreading crops around the globe and about related theories. Although never phrased that way, this was probably Seerp's first encounter with ideas on scaling innovations.

Seerp studied Rural Sociology at Wageningen University, specialising in the sociology of rural development combined with tropical crop science. After graduating, he did research on the topic of inter- and transdisciplinary collaboration, a subject that is as topical today as it was back then, although transdisciplinarity was frowned upon at the time and is much more accepted in the scientific community today.

Between 1993 and 2003, he lived with his wife in Nepal and then in Tibet (China), where their son spent the first years of his life. He worked there as programme manager with an international NGO in the field of community forestry, rural water supply, and high-altitude farming.

In 2003, he joined the International Agriculture Centre (IAC), which after a number of changes is now the Wageningen Centre for Development Innovation (CDI). He initially worked in the field of planning, monitoring and evaluation. Currently, his work revolves around integrated approaches for sustainable development in different capacities.

Outside office hours he enjoys his long-time interest in plant sciences through the hobby of gardening and hybridising daylilies (Hemerocallis spp.) at Wageningen Campus, where he planted seeds that grew into close to one thousand plants involving 200+ crosses of the latest daylily cultivars. He is a fervent reader of non-fiction books, taking a special interest in history, practical theology, and the evidence base for Christian faith.

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