Creating Inclusive Biobased Value Chains; A Reflection on the LINK Methodology

TU Delft

WAGENINGEN
UNIVERSITY & RESEARCH

Authors:

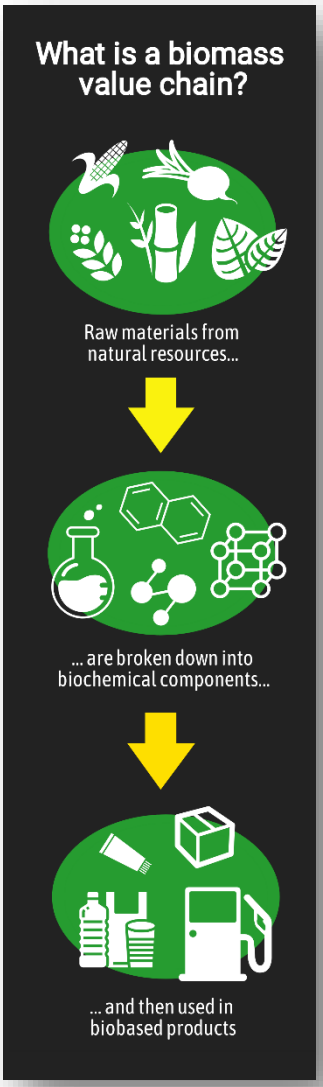
Ilse Oosterlaken (TUD), Lotte Asveld (TUD), Eefje de Gelder (TUD), Patricia Osseweijer (TUD), Zoe Robaey (WUR), Emiel Wubben (WUR)

This report is one of the outputs of the research project 'Inclusive Biobased Innovations' (IBIS), a joint project by the Biotechnology & Society Section of Delft University of Technology and the Business Management & Organization Division of Wageningen University & Research. The project received funding from the Netherlands Organization for Scientific Research (NWO). For more information on the IBIS project, please visit https://tudelft.nl/bt/ibis.

This report builds on the LINK Methodology, but is the sole initiative of the researchers in the IBIS project; Approval from the creators from the LINK Methodology has not been sought and therefore they cannot be held responsible for any of the contents of this document.

Table of Contents

Introduction



The idea of a bioeconomy presents a compelling vision of a sustainable society in which biomass – such as (the residu of) corn, bamboo, and sugar cane - provides the raw materials for all kinds of products. While the technology to extract raw materials from these feedstocks becomes increasingly available, the large-scale industrial application of biomass still raises challenges. Key challenges in the creation of biobased value chains are (see e.g. Asveld et al, 2014 & Bos-Brouwers et al, 2012):

1. *Feedstock availability and quality*; Present business models for biorefineries and the production of chemicals and biofuels depend on low costs and a reliable supply of feedstocks.
2. *Sustainability*; Sustainable biomass production requires making changes in agricultural practices, which will only happen if that also adds value for the farmers themselves.

Tackling both challenges is only possible if all actors in the industrial value chain become better aligned. And in particular, the pro-active inclusion of farmers in the process of designing and shaping biobased value chains is needed. Although a subtantial amount of scholarly work has over the years already been done on creating more inclusive agro-food value chains (see e.g. Devaux et al, 2018), creating inclusive biobased value chains may come with its own challenges that need to be addressed.

The IBIS project therefore aimed to explore which factors hamper or promote inclusive, succesful biobased value chains. We have done that through four qualitative case studies of different feedstocks providing biomass in different countries. It was our assumption from the start that understanding the local context is key for succesful value chain development. What can be or should be done to improve a specific value chain can only be determined after careful consideration of the specifics of that value chain and extensive consultation of the various actors and stakeholders. And understanding local values and perceptions is key in this process.

Of course not all factors are completely different in each context. One of our aims in looking at very different cases (more on the cases in chapter 1) was to distinguish between factors that are very specific to the local context and factors that are important to take into acocunt in any process to develop biobased value chain. As a result of our project, we have gained a lot of valuable knowledge and insights. Yet our research was neither intended nor set up to provide straightforward solutions and universally applicable advice to producers of biobased products and other actors / stakeholders in biobased value chains.

To create action-oriented roadmaps, actors in biobased value chains could potentially benefit from a variety of practical guides that have over the years been developed for value chain development more broadly (see Donovan et al, 2015). One such guide is the LINK Methodology / Toolkit for inclusing smallholders in agro-food value chains, which was developed a few years back by the International Center for Tropical Agriculture (CIAT) in collaboration with a number of partners.

According to Donovan et al (2015, p. 7) it "*relies heavily on sustained engagement with smallholders and other chain actors to understand the chain and facilitate negotiations and interactions between actors*", it pays substantial attention to context (p.10) and "*workshops and key informant interviews form the methodological pillar*" (p.14). We also appreciate the emphasis that is put on value chain development as a learning process involving all stakeholders in the value chain. Thus, the LINK Methodology suits the starting points and qualitative approach of the IBIS project (more on the project in chapter 1). It is also one of two guides that according to Donovan et al. (p.15) "*provide the most extensive set of indicators for monitoring*", which is also an attractive feature.

The aim of this report is to provide a first exploration of how the findings of the IBIS research project can be connected to the LINK guide:

A. Where could sector-specific knowledge and insights from the literature on biobased value chains and more specifically the IBIS project be 'plugged into' the LINK Methodology as it is?
B. To what degree is LINK fully applicable to and sufficient for creating sustainable, inclusive biobased value chains? Are there gaps that need to be addressed?

The next steps after this exploration, so we propose, is to

1. Test the LINK Methodology with the companies and other stakeholders that were involved in our case studies, taking the findings of this exploration into account.
2. Provide a user-friendly extension to the LINK guide that allows anyone working on biobased value chains to easily use it while taking the findings from this exploration and the lessons from the test sessions into account.

In this way, we hope to strengthen the bridge between these research findings and the practical needs of the practitioners and stakeholders who have provided support for and participated in our research project. We consider this discussion to be explorative and open ended, and look forward to further discuss the topic with all stakeholders in the years to come.

The set up of this report is as follows. First we will provide some further information on the IBIS project in chapter 1. Subsequently the LINK toolkit will be introduced in chapter 2 (and we will also make one general proposal to extend this tool that is not specific to biobased value chains, but may benefit anyone using the toolkit). In chapter 3 we will explore the applicability and sufficiency of LINK for creating sustainable, inclusive value chains (question B above). In chapter 4 we will discuss some pieces of knowledge and insights that should be taken into account when applying the LINK Methodology (question A above).

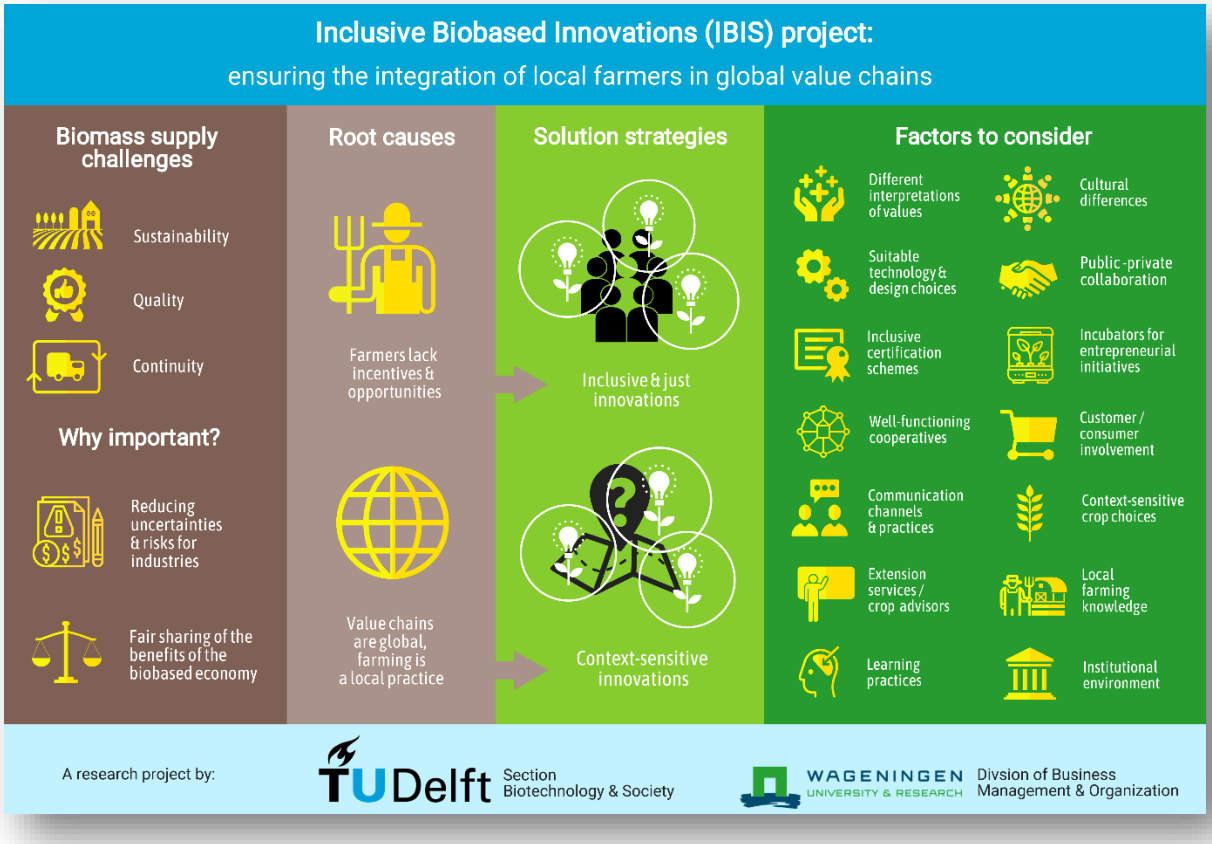
1. The IBIS Research Project on Inclusive Biobased Value Chains

1.1 Introduction to the Project

Inclusive Biobased Innovations (IBIS) is a joint research project by the Section Biotechnology & Society (Faculty of Applied Sciences, Delft University of Technology) and the Division of Business Management & Organization (Department of Social Sciences, Wageningen University). The project was funded by the Netherlands Organisation for Scientific Research (NWO). It ran from July 2017 until November 2020. Through an extension grant from São Paulo Research Foundation (FAPESP) researchers from the Universidade Estadual de Campinas (UNICAMP) also contributed to the project. The IBIS project draws among others on the literatures on responsible innovation (see e.g. von Schomberg, 2019) and designing for values (see e.g. Van den Hoven, Vermaas & Van den Poel, 2015), processes in which stakeholder participation is considered to be of great importance.

The IBIS research project departed from the assumption that the challenges outlined in the introduction – feedstock availability & quality and sustainability - in particular require the pro-active inclusion of farmers in the process of designing and shaping biobased value chains. This is desirable not only to take their values and interests properly into account, but also because they have knowledge that is invaluable to a sustainable bioeconomy, e.g. on crop management and supply options, biomass composition, storage, handling options and nutrients and water recycling. In addition, farmers may be expected to more readily deliver biomass meeting quality standards when they consider themselves essential and equal participants in the value chain.

The infographic below summarizes the key ideas behind the project and factors that were found to be important for building inclusive biobased value chains.



1.2 Case Studies in the IBIS Project

Our project team first studied non-technological factors for failure and success in the development of biobased value chains in the Netherlands, focussing on potatoes and sugar beets. Subsequently we did four explorative, qualitative case studies on different feedstocks in the USA, Iowa (corn), Brazil (sugar cane, soy bean, and macaúba), South Africa (tobacco) and Jamaica (bamboo and king grass. In all these instances, the crop – either the residues of the plants after harvest and/or processing that used to be considered waste or the dedicated energy crop - can be used to produce (a specific type of) bio-fuel, and in all our case studies there were indeed companies looking to set up a value chain that does just that.

	Low tech availability	**High tech availability**
Small & medium scale	Jamaica (bamboo & king grass)	The Netherlands (potatoes & sugar beets), South Africa (tobacco)
Large scale	Brazil (sugar cane, soy bean, macaúba)	Iowa, USA (corn)

Through our choice of cases, we included situations with both a high and low technology level, and with biomass production on a small/medium and a large scale (see the matrix below). The Netherlands is a net importer of biomass, Jamaica a net exporter. The USA, South Africa and Brazil offer interesting cases on local business development within biomass value chains.

Our data collection consisted of semi-structured interviews with relevant stakeholders. Sometimes, one interview was conducted with several interviewees. We also conducted workshops where we engaged with our partners to reflect on the challenges. Finally, we also carried out several site visits. These site visits were accompanied by interview-like conversations aiming at a deeper understanding of the practices of each case. In this way, we mapped various relevant actors and their particular interests and perspectives and we identified structural and local challenges and solutions. For the outputs of this project – including presentations and publications - please visit our project website.

The next chapter will introduce the LINK Methodology to create inclusive value chains – and make one general proposal to extend it that we think is useful for anyone using the toolkit, not just for people working on biobased value chains. This introduction to the LINK Methodology is really succinct and will focus on those elements that are most relevant to the discussion in chapters 3 and 4 that connects the IBIS Project and LINK. We therefore encourage readers to consult the LINK guide for a further explanation of each of the tools, as well as concrete advice on how to use the toolkit in practice.

2. The LINK Methodology / Toolkit (and One Proposal to Extend It)

2.1 Introduction to the LINK Toolkit

The LINK Methodology developed by CIAT (Lundy et al, 2014) is "*a participatory guide to business models that link smallholders to markets.*" It is based on literature, various research projects in Latin America and Africa and "*successful results from more than 40 business model cases demonstrating functionality for small-scale producers*" (p.9).[1] Case examples presented in the guide include a coffee supply chain in Nicaragua, a fresh fruit and vegtables chain in Colombia, a cooperative exporting vegetables from Guatemala, aromatic plants produced in a small village in Colombia, a smallholder cocoa producer organisation in Ecuador, a vegetables producer organisation in the Phillipines, a rual retailer business in India, and a fresh organic produce network in the USA and Mexico.

LINK was primarily developed to be used by organisations which would like to bring farmers and other actors in the value chain together, such as NGOs that see this as a way to improve the situation of smallholders. However, in the guide it is mentioned that it could also be used by (cooperatives of) agricultural producers or companies buying their products. And regardless of who takes the initiative to improve a value chain and use the LINK toolkit for this purpose, the process of applying the tools should ideally always include both direct and indirect actors in the value chain in the analysis and subsequent discussion. This will lead to the best results and a realistic, feasible plan of action.

Just as in the IBIS project, the underlying idea is that both the farmers and the companies further down the value chain may benefit from increasing the inclusion of farmers. However, it is noteworthy that this benefit is not the direct aim of the toolkit (p.28):[2]

> *"Of course, all actors hope that revising a business model will improve performance and, indeed, improved performance is necessary in order to build long-lasting trade relationships. However, the focus of this guide is on inclusivity rather than general performance. We are not trying to improve the performance of each actor, but to build inclusive business models which contribute to increased interdependence within the value chains."*

The LINK Methodology consists of four main tools to achieve that goal of inclusion (p.13):

1. *"**The value chain map** (used to understand the macro context of markets and the businesses which link rural producers with buyers);*
2. ***The business model canvas** (used to understand in more detail each business which links rural producers with buyers);*
3. ***The New Business Model principles** (used to determine whether each business which links rural producers with buyers is truly inclusive).*

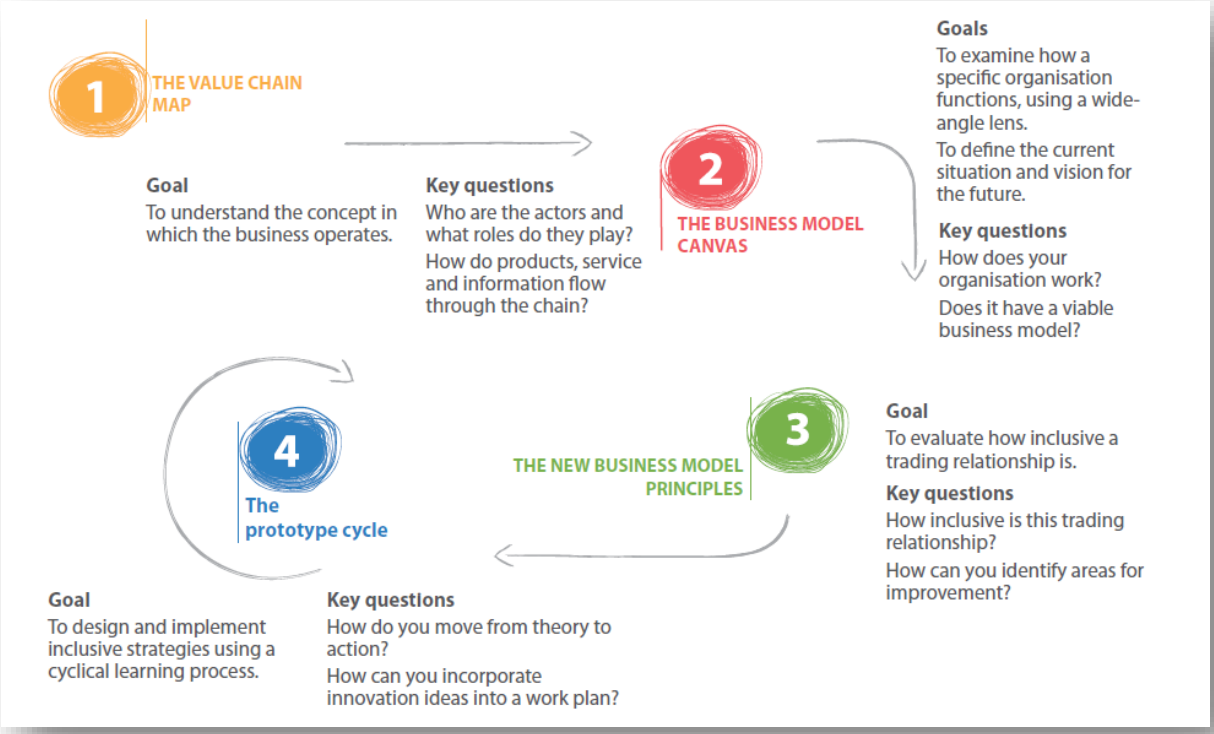
Source: Lundy et al, 2014, p.19

[1] According to Donovan et al. (2015, p.5) "CIAT's guide for value chain development was first published in Spanish in 2003. A revised version was published in 2007 in English and Spanish". The version of guide that we use in this report, published in 2014, is another revision.

[2] A more extensive reflection on the distinction and relationship between inclusivity and business performance can be found on page 152 of the guide.

4. ***The prototype cycle*** *(used to continuously improve the inclusivity of every business which links rural producers with buyers).”*

The infographic below, copied from the LINK guide, presents the goal of and key questions addressed by each tool[3]. In the remainder of this chapter we will introduce each of the tools.



Source: Lundy et al, 2014, p.22

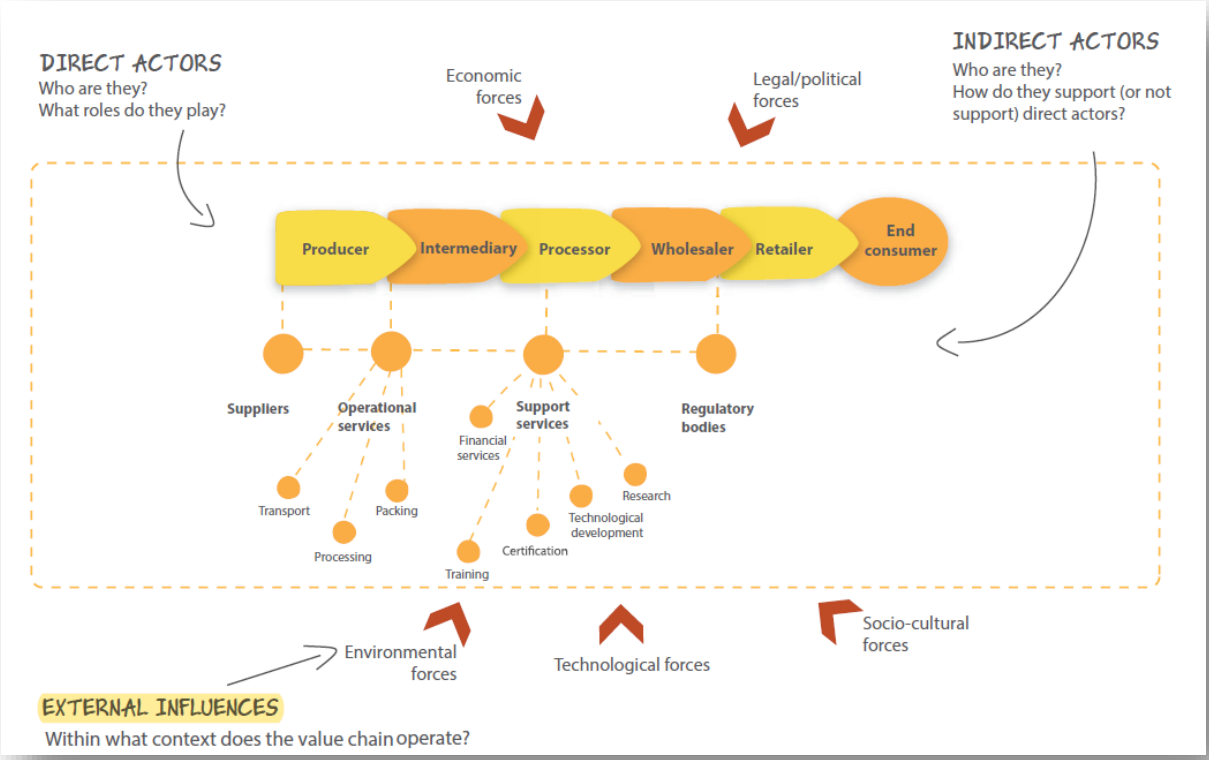
2.1 Tool One: The Value Chain Map

The essence of tool one is a checklist that allows you to get a good overview of the value chain as a whole. Users of the guide are encouraged to connect the information collected to a visual representation of the value chain, such as shown in the image below. There are three phases of information collection, with each a number of items, and for each item the guide presents a list of questions to be asked:

1. *Mapping the actors and their relationships*
    a. *The direct actors and their roles*
    b. *The indirect actors and their roles*
    c. *Product flow and information flow*
    d. *Relationships between key actors*
    e. *Product characteristics*
2. *Mapping commercial figures*
    a. *Prices and payments*
    b. *Volume*
    c. *Returns*

[3] There seems to be an error in the formulation of the goal of tool 1, the value chain map, in this infographic. This should be to understand the ‘context’ in which the business operates rather than the ‘concept’.

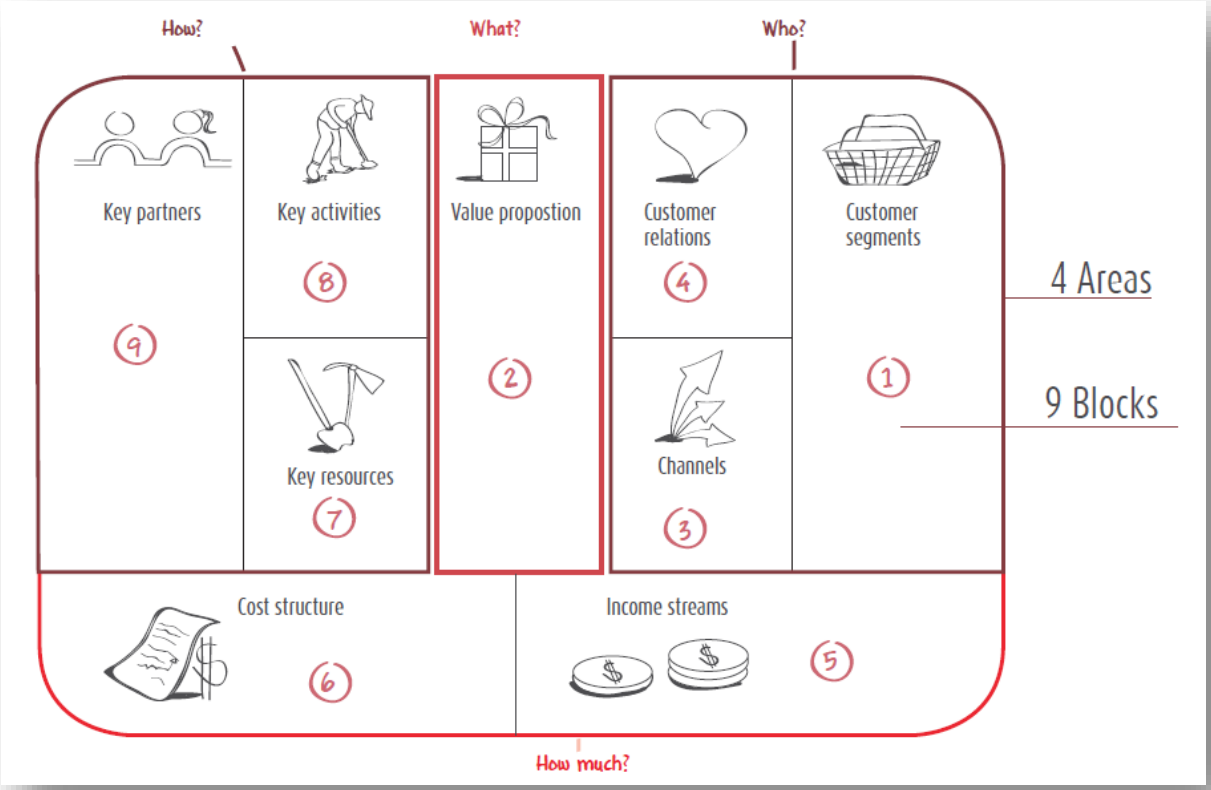
3. *Mapping external influences*
    a. *Economic forces*
    b. *Political / legal forces*
    c. *Socio-cultural forces*
    d. *Environmental forces*
    e. *Technological forces*



Source: Lundy et al, 2014, p.36

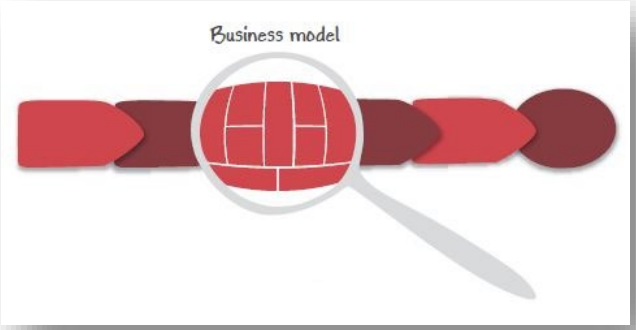
2.2 Tool Two: The Busines Model Canvas (BMC)

The second tool in the LINK toolkit is the Business Model Canvas, which was developed by Osterwalder & Pigneur (2010) and has since become a widely used tool in the business world (see e.g. Heinike et al, 2019). The Business Model Canvas is a visual tool that allows you to zoom in on individual businesses that are part of the value chain. It consists of nine blocks that can be filled out to get a picture of how a particular business creates value (left half of the canvas) and captures value (right half of the canvas):



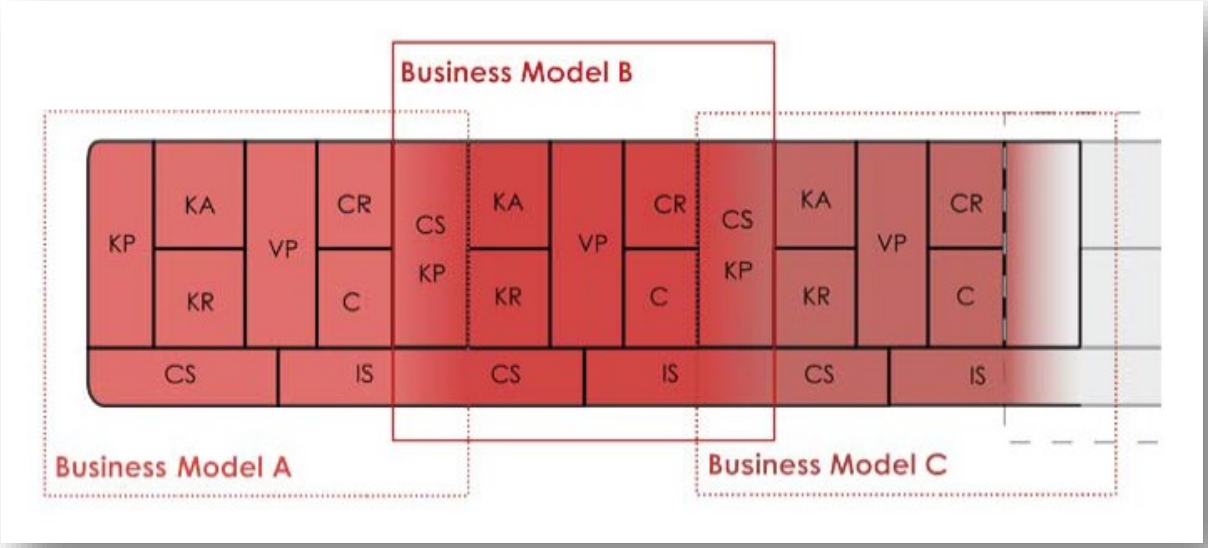
Source: Lundy et al, 2014, p.52

The LINK guide explains (p.51) that "*the direct actors' business models form the value chain, as a value chain is quite simply a linking of several business models*", as illustrated in these two pictures:



Source: Lundy et al, 2014, p.51

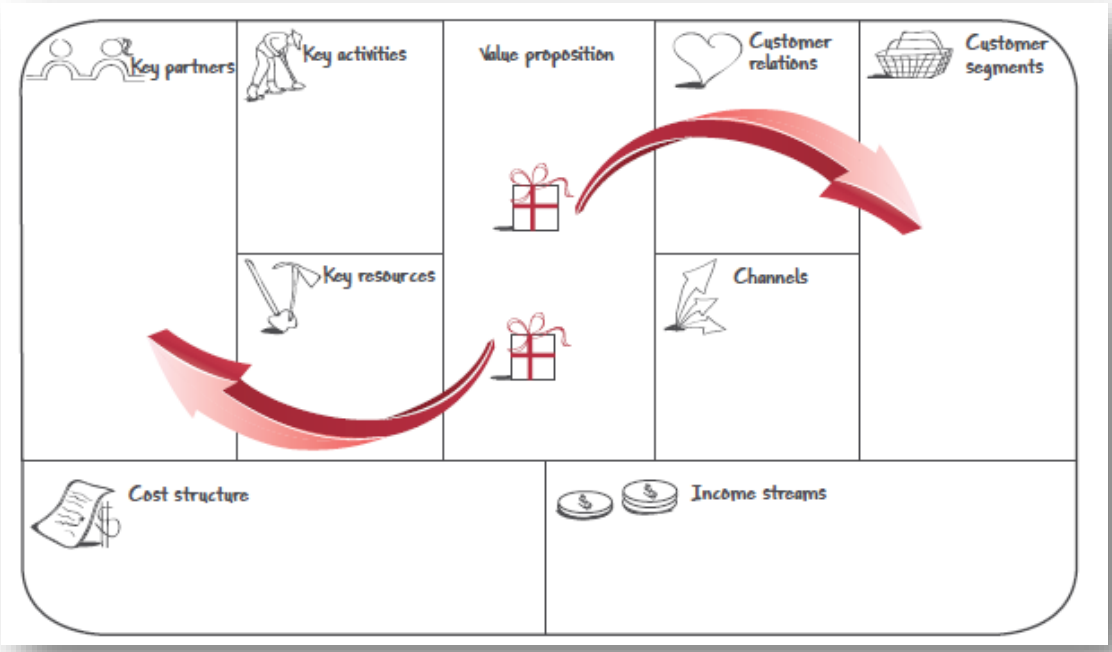
The picture below illustrates that "*in a value chain, each actor is both seller and buyer to their neighbouring links. A solid value chain needs strongly connected links in order to face internal and external stress factors*" (p.54). It is thus useful to apply the Business Model Canvas to several or all actors in the value chain and use it as input for a discussion of the strength and quality of these connections.



Source: Lundy et al, 2014, p.54

An interesting and very useful addition that the LINK guide makes to the Business Model Canvas, is the concept of a "double facing value proposition" that companies who wish to include farmers in the value chain should be able to make (p.66, see also the illustration below):

> *"In inclusive business models, it is important to look at the value proposition from at least two perspectives: (1) from the producer's point of view and (2) from the customer's perspective. Inclusive business models should be sensitive to the realities of smallholder production as well as to market demands."*

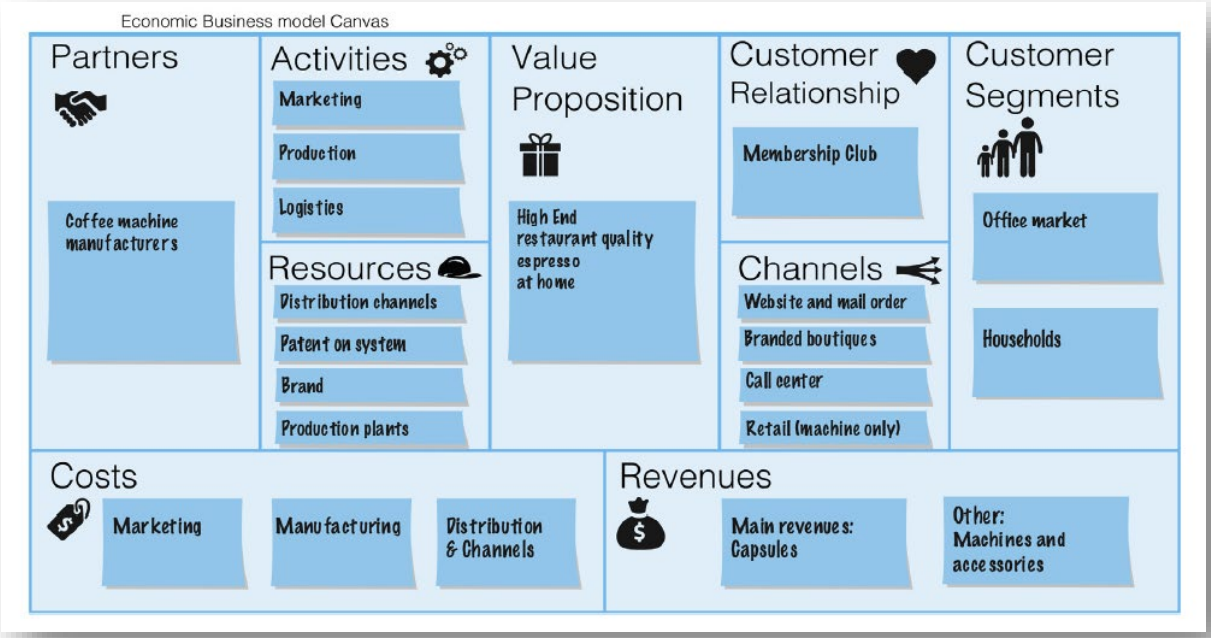


Source: Lundy et al, 2014, p.66

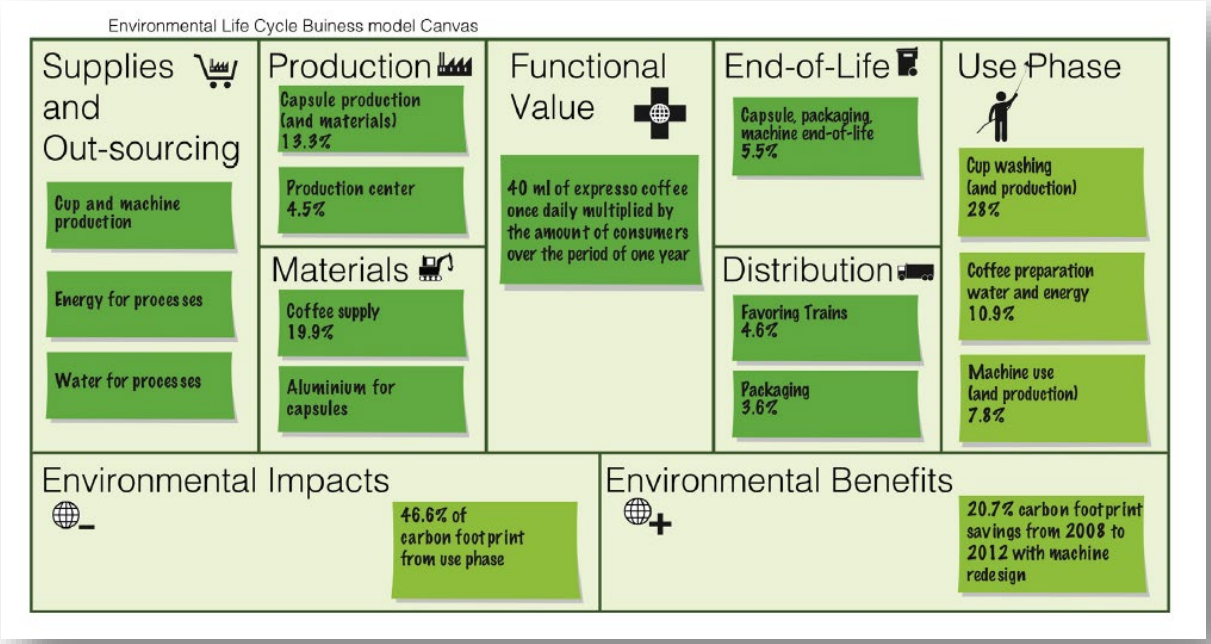
2.4 Intermezzo - Adding 'People' and 'Planet' to 'Profit': The *Triple Layered* BMC

In 2016, so two years after the second and revised version of the LINK Methodology had been published, Joyce & Pacquin published a proposal to extend the Business Model Canvas (BMC). The original BMC is focussed on the creation of financial value, or the *profit* that a company makes. However, in the past decades awareness has grown that without paying attention to *people* and *planet* as well, business can in the long run not be sustainable. The extended Triple Layered Business Model Canvas (TLBMC) of Joyce & Pacquin acknowledges this and enables companies to also take social and sustainability values into account when reflecting on their business model. It does so by adding two additional canvasses addressing these values, as shown in the images below. These images include an analysis of the case of Nespresso, which Joyce & Pacquin present in their article.

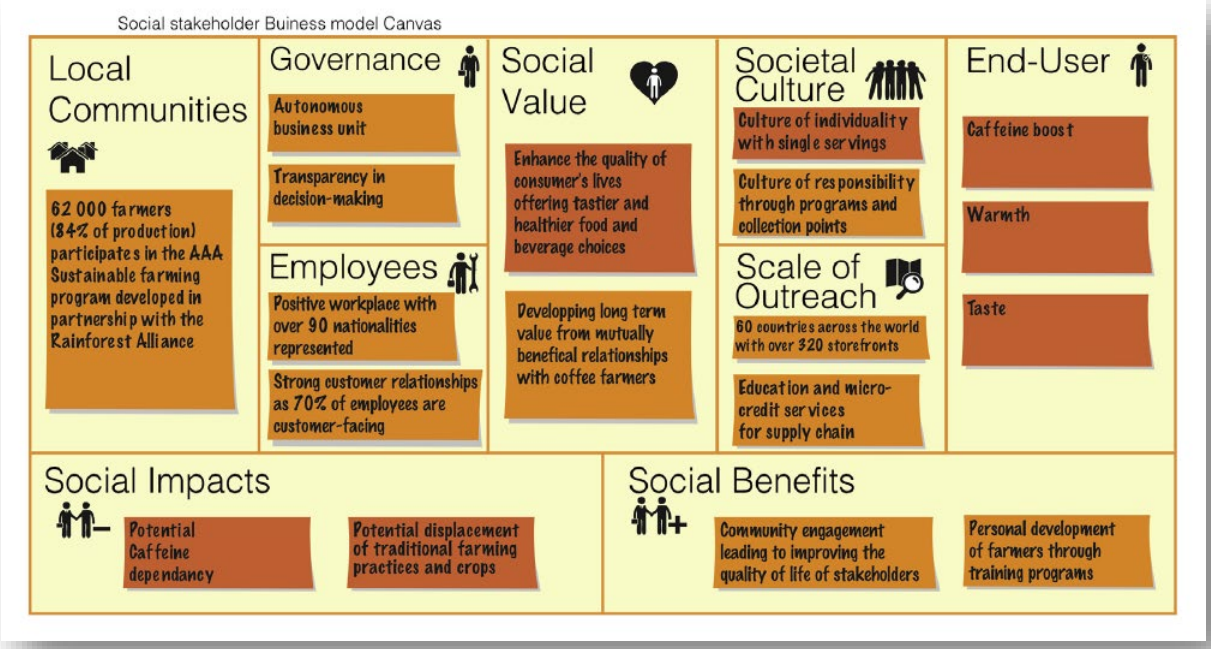
This extension of business thinking beyond profit is also of great importance for the future of the biobased economy (Asveld et al, 2014). The alignment of actors in the value chain should be guided by a proper understanding of key societal values like distributive justice, sustainability and trust. Although we have not used or tested this extended BMC in the IBIS project, some of the members of the IBIS research team have positive experiences working with it in the context of teaching and other research projects. We expect that it should not be difficult to integrate it in the LINK Methodology, and think that this would be a useful addition. Therefore, we have decided to briefly show here what Joyce & Pacquin proposed before moving on in the next chapter to integrating the outcomes of the IBIS research project in the LINK Methodology:



Source: Joyce & Pacquin, 2016, p.1476

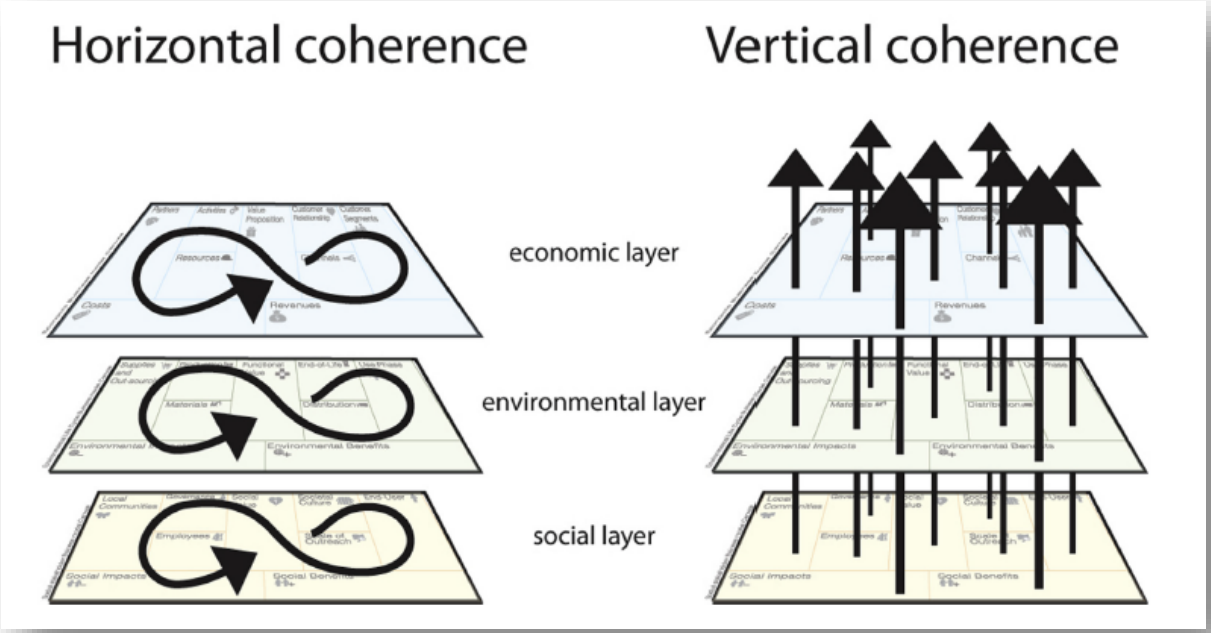


Source: Joyce & Pacquin, 2016, p.1479



Source: Joyce & Pacquin, 2016, p.1480

According to Joyce & Pacquin their TLMBC "*provides 'horizontal' coherence within each canvas layer for exploring economic, environmental and social value individually and 'vertical' coherence integrating value creation across the three canvas layers; which supports developing a deeper understanding of an organization's value creation*" (p.1477). The next image illustrates this:



Source: Joyce & Pacquin, 2016, p.1482

If this sounds of interest to you, we encourage you to read more on the triple layered business model canvas in the original article by Joyce & Paquin.

2.5 Tool Three: The Inclusive Business Model Principles

In the third tool, the LINK team offers six principles for inclusive business, which are not meant "*as a normative checklist that must be achieved*", but rather as "*signposts that indicate issues and / or topics on which care should be exercised*" (p.86) when developing inclusive value chains. They "*highlight critical success factors for improving inclusivity, fairness, durability and financial stability in business relations between small-scale producers and formal buyers (who may be processors, exporters, wholesalers, retailers, etc.)*." The LINK principles are:

1. Chain-wide collaboration

2. Effective market linkages

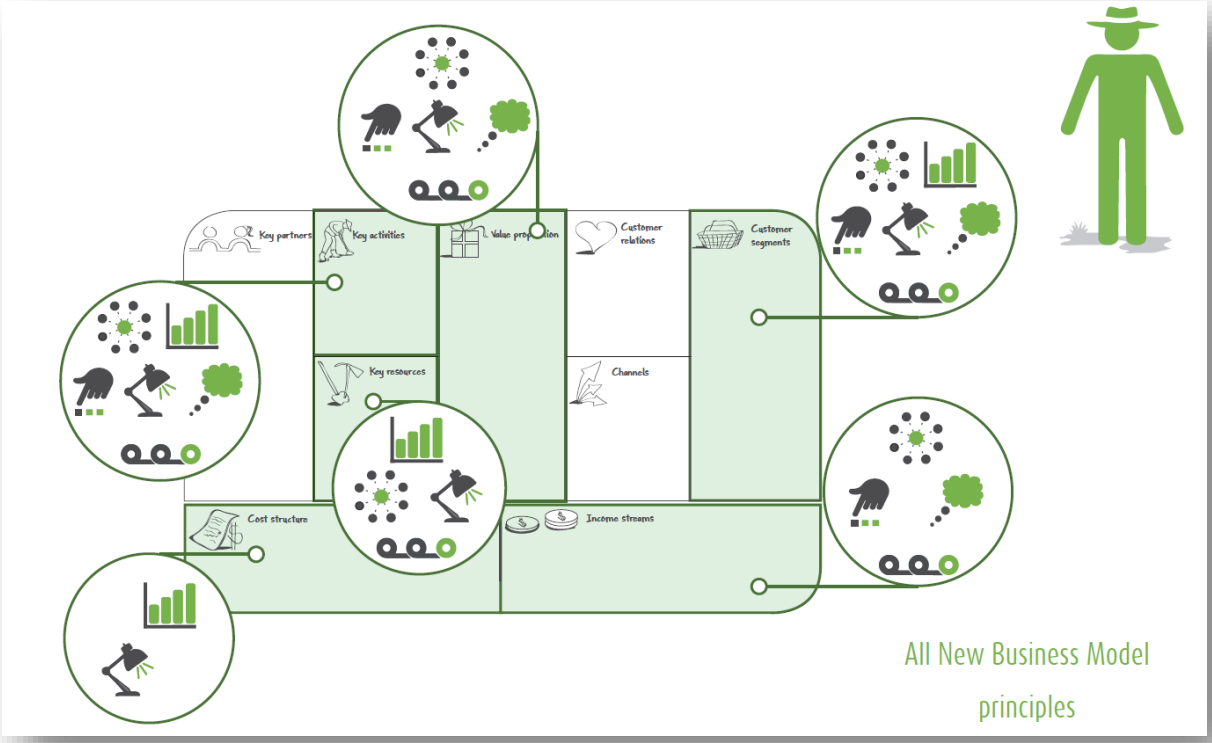
3. Fair and transparent governance

4. Equitable access to services

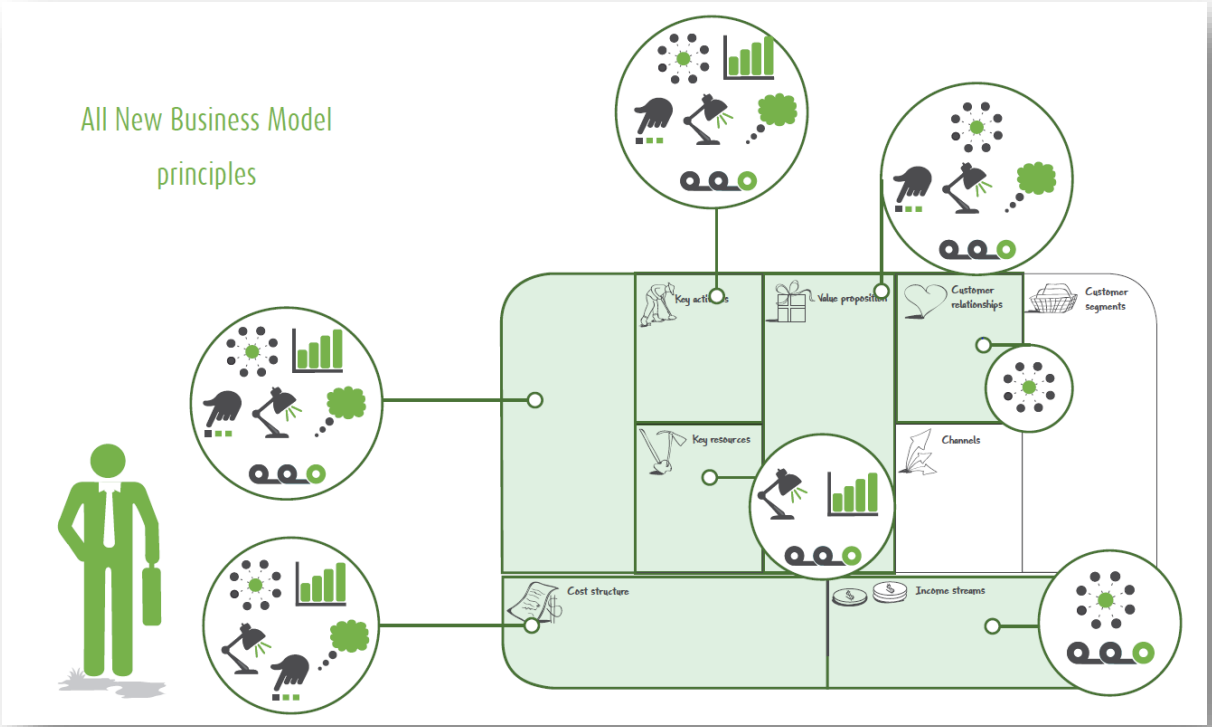
5. Inclusive innovation

6. Measurement of outcomes

For each principle, the guide offers a description, questions to be asked when discussing the principle and a scorecard to determine how well the current situation meets these principles. Interestingly, the guide also shows for which elements of the business model canvas each principle is relevant, from both the perspective of the seller of crops and the buyer:



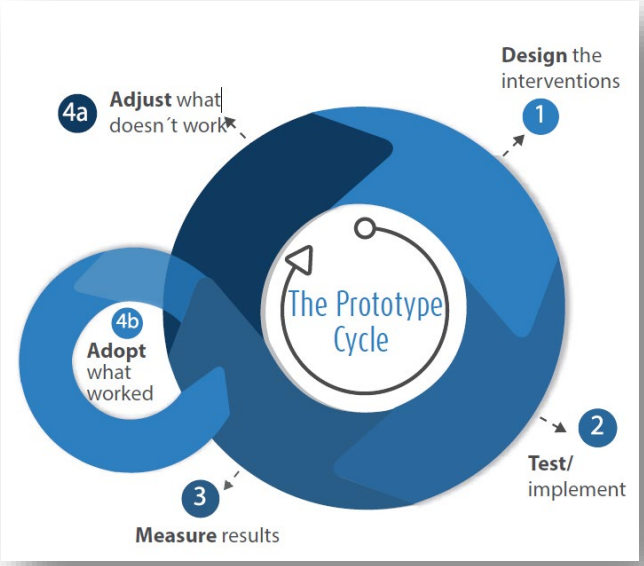
Source: Lundy et al, 2014, p.106



Source: Lundy et al, 2014, p.107

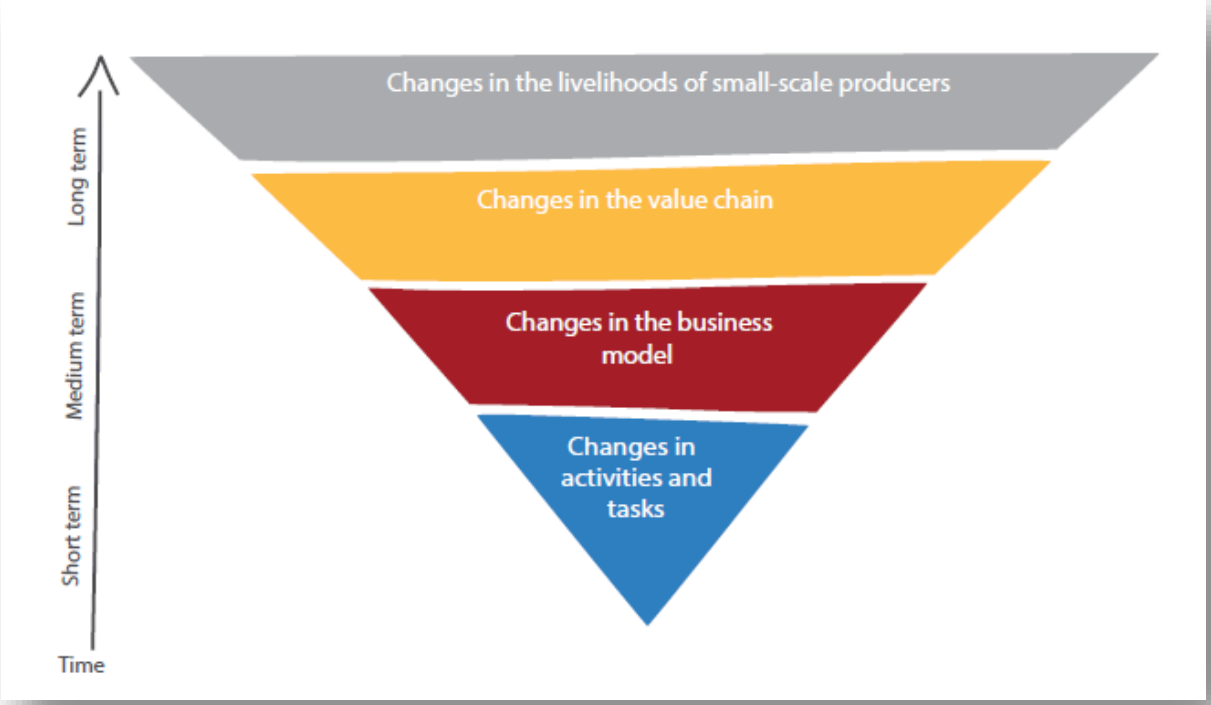
2.6 Tool Four: The Prototype Cycle

The fourth tool consists of a process to make an action plan and continuously adjust it as the value chain develops further and actors learn new things:



Source: Lundy et al, 2014, p.150

The chapter on tool four distinguishes between three types of results that the action plan (the blue triangle) can be expected to bring about, in the order of how long it takes to realize them. For each of these levels of results, the LINK guide gives a quite extensive list of examples of indicators that could be monitored to see if the changes occur.



Source: Lundy et al, 2014, p.155

Having given a brief introduction to the LINK Methodology / guide, we will in the next chapter move on to the findings of the IBIS project and how they relate to this method / guide.

3. The Applicability and Sufficiency of LINK for Biobased Value Chains

Overall, as mentioned already in the introduction, the IBIS team appreciates the LINK Methodology / Guide and all the work that has gone into developing it. Attractive aspects include the recognition of the importance of context and the need for sustained interaction between farmers and other stakeholders, an approach which the IBIS project shared. We also appreciate the emphasis that is put on value chain development as a process of learning in tool four.

Knowledge and insights gained from the biobased value chain literature and the IBIS project can definitely be used as *input* in the process of *applying the LINK tools* for developing inclusive biobased value chains (some things to be aware of / to pay attention to are listed in chapter 4). Yet in addition the IBIS project can also be seen as providing an opportunity to reflect on *the LINK Methodology itself:*

1. To what degree is the LINK Methodology (developed for improving agro-food value chains) fully applicable to biobased value chains and the type of cases that we have investigated in the IBIS project?
2. Does following the LINK Methodology ensure that you will start to think about all factors that matter for realizing a biobased value chains (as found in our cases or discussed in the wider literature)? Or are there gaps and discrepancies?

For example, in their comparison of value chain development guides Donovan et al (2015, p.16) mention the LINK guide as one of the guides that are "*particularly suited to developing value chains that link smallholders to local markets*", while other guides "*are especially appropriate for links to export markets"* (such as a World Bank guide). So, it may not be insignificant that biobased value chains tend to be global in nature[4], and it may be worth investigating further how important it is and if the LINK guide needs to be supplemented to deal with this difference.[5] However, in this chapter the IBIS team has decided not to address this issue, but focus on the following topics and issues:

(1) the complexity of biobased value chains;
(2) sustainability in biobased value chain development;
(3) the double-faced value proposition and the entanglement different value chains;
(4) crop choice and source requirements;
(5) technology and biorefinery design;
(6) the variety of views on the ends of inclusion;
(7) the means of inclusion

3.1 Reasons Why Developing Biobased Value Chains May Be More Challenging

In various ways, we believe, building inclusive biobased value chains is even more complex than the challenging process of improving the type of value chains that the LINK Methodology was developed for:

- **It concerns completely new value chains.** The LINK Tool was made to better include farmers in existing agro-food value chains. Yet the challenge that the stakeholders in our case study face, is

[4] It is noteworthy though that the biomass investigated in the IBIS cases was never directly exported but instead first processed by a local biorefinery. This is no coincidence: "the transportability of biomass is often limited due to its low density and susceptibility to decaying." (Zörb et al, 2018, p.93).
[5] Unfortunately, Donovan and colleagues do not elaborate on what makes certain guides more appropriate for certain types of markets than others.

setting up completely new value chains of a type that did not exist before, using new technologies that are still under development. This may be relevant for at least two reasons:
    - It seems plausible to assume that there are more uncertainties and risks when developing this new type of value chains. Would tool 2, the business model canvas, sufficiently support stakeholders in exploring these uncertainties and risks, or are additional tools recommendable?
    - For the bioeconomy there are also still fewer supporting institutions and practices in place, such as appropriate certification programs. Tool 3, the value chain map, encourages stakeholders to identify relevant external influences – whether positive or negative – and thus this does not necessarily provide an argument against the applicability of the LINK Methodology. Nevertheless, we feel it is good to keep in mind that a new type of value chains may come with new challenges.
- **It concerns very complex value chains.** The depiction of value chains in the first LINK tool is rather straightforward, with a product moving from farm to consumer via intermediaries, with perhaps a little processing and packaging on the way. However:
    - In the bioeconomy value chains, so Zörb et al. (2018, p.89) argue, are quite complex "due to the vast applicability of biobased raw materials", and thus it is better to illustrate them "in a so-called value network (or value-added network), which integrates multiple value chains." This does not mean that the LINK toolkit cannot be used, but additional complexity is to be expected, and questions may need to be added to the toolkit to ensure that these extra layers of complexity are discussed by the stakeholders involved.
    - In addition, there is also a specific principle that is important for improving biobased value networks, namely that of 'cascading use' (see e.g. Odegard et al, 2012). "Although it is not a new concept," say Zörb et al. (2018, p.91), "it has gained attention in recent years." It adds an extra layer of complexity:

        > *"To establish cascading of biological resources on an economy-wide scale, entire biobased value chains have to be formed and eventually integrated in value networks. The development of new biobased value chains requires cooperation between previously unconnected sectors in order to handle the specific characteristics of bioeconomic value chains."*

- **Entangled value chains at the level of the farm**. At the basis of these already complex value networks, the farms, the value chain is often entangled with agro-food value chains. This will be further addressed in §3.3.
- **It involves complex and still quickly evolving technology**. The technological complexity of biobased value chains is larger than that of the agro-food value chains for which the LINK Methodology was developed. This will be further addressed in §3.4.

3.2 Sustainability in Biobased Value Chain Development

Sustainability is a very important point of debate in the literature on the transition to a biobased economy (Palmeros Parada et al, . Although the LINK guide does mention sustainability on occasion, we think that it merits more and more systematic attention in the process of building and improving value chains. Replacing the Business Model Canvas with the Triple Layered Business Model Canvas, as we proposed in §2.4, goes some way towards addressing the issue of sustainability. However, more change to the LINK guide might be recommendable, such as including sustainability indicators in the chapter on tool 4 (the prototype cycle). This is something that, in our opinion, definitely deserves further attention. One specific part of the development of biobased value chains where sustainability is important is the design of biorefineries (see later in this chapter).

3.3 The Double-Faced Value Proposition and the Entanglement of Value Chains

A key actor in the value chain from biomass to bioproducts are biorefineries, which process the biomass and break it down into biochemical components that can subsequently be used in the production of further goods, such as biofuels for aviation and various consumer products. Our case studies show that it is indeed very important for these biorefineries to develop – to borrow a term from the LINK guide, see the end of §2.2 - a "double faced value proposition" in which they not only take a critical look at what they have to offer to customers 'down' the value chain, but also to what they have to offer to the farmers 'up' the value chain. To develop this value proposition for farmers, it is important – as the LINK guide states (p.66) – to be aware of and sensitive to the realities of farmers. For many biochemical companies interested in becoming part of the bioeconomy this may be new terrain, as these companies are traditionally not used to dealing with farmers as suppliers.

Yet, as said, the case studies clearly showed how important it is for these companies to understand the values, interest and needs of farmers. Interview with our project partners, and in particular with biorefinery operators in Iowa, made clear that biorefineries need a stable input of biomass to be able to run their processes in a continuous fashion, so that they can sell on the market in a consistent and predictable manner. From these interviews, we understood that 'a stable input of biomass' has three requirements: quality and quantity of the biomass, the consistency in delivery, and the long-term predictability and type of feedstock, for at least 5 years. This is the period that seems feasible to make a reliable business plan. From the perspective of biochemical companies these requirements are not out of the ordinary. Yet the realities of farming make this hard to realize:

1. Concerning the quality and quantity of biomass, farmers face challenges from unexpected weather events, or the potential of pests, in other words, sometimes there are bad seasons.
2. Concerning the consistency in delivery, harvest is seasonal because crops need time to grow, cannot be stored for a long time before being processed, and therefore challenge the need for consistency in delivery.
3. Concerning long-term predictability and type of feedstock, farmers may choose to rotate crops. Decisions on crops may be made year by year, and can depend on several factors such as soil health, market dynamics, or state incentives.

Biorefineries have to be very aware of these realities and challenges for farmers.

What makes it even more challenging for biorefineries to developing this 'double-faced value proposition' and set up a successful value chain, is when the biobased value chain it at the level of the farm entangled with an agro-food value chain; In biobased value chains usage is sometimes made of the waste products of crops which are already used for consumers or for fodder. In the case of corn in Iowa, for example, the biomass that the biorefinery wanted to use was corn stover: the leaves, stalks, and cobs of corn plants left in a field after harvest. Farmers may welcome the additional income that selling these former waste products brings, but it is not their primary source of income. This makes it even more important for biorefineries and other companies up the value chain to consider their value proposition to farmers. Moreover, when making plans to improve the biobased value chain, it should be taken into account that measures and actions proposed will also have to be judged on their potential effects on the agro-food value chain in question.

3.4 Crop Choice and Source Requirements

3.5 Technology and Biorefinery Design

In the LINK method technology is only mentioned 'in passing', as one of the external forces in the environment that needs to be taken into account. But we believe it is very central to building inclusive, sustainable, successful value chains. The design of bio-refineries should align with the needs, values and knowledge of biomass producers and other relevant actors. For instance, the bio-refinery should not rely on high end technologies if locally the skills of potential workers are not sufficient to operate such technology. Also machinery for cleaning and sorting biomass should be provided in line with the skills, needs and knowledge of the biomass producers. In some contexts, farmers may want to own high tech equipment for cleaning, to keep control over the supply of feedstock. However, in other contexts, farmers may want to transfer the investment risk to other parties such as the owners of the biorefinery.

Other elements that may differ between biorefineries are mentioned by Zorb et al (2018, p.91): "Biorefinery systems differ according to the (1) flexibility to process various types of feedstock, (2) characteristics of the conversion processes and (3) product diversification (Sadhukhan et al. 2014)." How to shape these elements in a way that is most productive and socially sustainable will differ per context. Palmeros Parada et al (2018 & 2021) present methods to integrate sustainability aspects and contextual aspects into the design of the biorefinery. By taking into account the values of the local participants, they show how an inclusive design of a biorefinery is possible.

4. Insights on Biobased Value Chains that LINK Users Should Be Aware Of

4.1 Applying Tool 1 (The Value Chain Map)

For step 1, **mapping the actors and their relationships**, it is important to keep the following in mind:

- Whereas households are the ultimate customer at the very end of the agro-food value chain examples in the LINK guide, in the case of biobased products **the customer at the end of the value** chain may be a company, such as an airline buying biofuels. This may have implications for how the value chain can best be shaped.
- Biomass is processed by biorefineries, which are usually run by large-scale industrial biochemical firms. That is a very different type of company from the processors, wholesalers and retailers that tend to be the **direct actors** in agro-food value chains. This will also lead to a whole different set of indirect actors being involved.
- **Smallholders versus larger farms with technology access.** The LINK Methodology has been developed for and tested on cases concerning smallholders in the global south. Some of our cases, however, concerned large and medium-scale farms in the global north, where farmers are often well educated have access to advanced technologies. Again, we can ask to what degree that makes a difference for the applicability of the LINK guide. It is a question to which we do not have an immediate answer, but that may merit further reflection.

For step 2**, mapping commercial figures** (such as prices, payments, volumes and returns), it is important to keep the following in mind:

- sometimes biomass is not a commodity crop, but rather a **non-commodity waste stream** that stakeholders are now trying to put to use. Various factors play a role in whether something becomes a commodity or not, including the size of the market and the availability of certification schemes to ensure a uniform quality. Whether something is a commodity crop has among others an influence on price development.

For step 3, **mapping external influences**, there are various influence that are particularly important for biobased value chains, including:

- the political climate around the utilization of biomass can be volatile. Supporting subsidy schemes can be altered in a relatively short timeframe due to new insights or more attention for specific values (Asveld, 2016). The Renewable Energy Directive of the EU poses new requirements to biomass for instance in 2020. This is particular for biomass production, and not present as much in the more stable food value chains.
- Another relevant external influences are the voluntary certification schemes. Schemes such as provided by the Roundtable on Sustainable Palm oil or the Roundtable on Sustainable Biobased Products provide potential biomass users with a set of criteria with which to assess the sustainability of the biomass used. Such schemes are very important in communicating reliability and trustworthiness to other actors in the value chain.

4.2 Applying Tool 2 (The Business Model Canvas)

As for the business model canvas for **farmers producing biomass**:

- The business model canvas will have to present a convincing set of benefits to the farmers, more than when they would be producing for a food value chain. A biobased value chain

present additional risks because of it's emerging status, which hence need to be balanced against additional benefits.

As for the business model canvas for **biorefineries**:

- A key factor for all actors in biobased value chains to be aware of, is that setting up a biorefinery is a complex and expensive investment with a **return-on-investment time** of about 20 years.
- Also this group faces many risks in setting up a new value chain. Possibly a category detailing all the risks should be added to the canvas, to provide a comprehensive overview of all relevant factors. Possible risk relate to security of supply, quality of the biomass, changing regulatory landscape. It would be good to explicitly take these into account.

4.3 Applying Tool 3 & 4 (The New Business Model Principles and the Prototype Cycle)

We believe these tools to be open and non-specific to such an extend that they can easily be applied to the context of the bioeconomy.

References

Asveld, L., J. Ganzevles, P. Osseweijer & L. Landeweerd. (2014). *Naturally Sustainable? Societal issues in the transition to a sustainable bio-economy*. Delft: Delft University of Technology

Asveld, L. (2016). The need for governance by experimentation: The case of biofuels. *Science and engineering ethics*, *22*(3), 815-830.

Bos-Brouwers, H., Langelaan, B., Sanders, J., Dijk, v. M. & Vuuren, v. A. (2012). *Chances for biomass: Integrated valorisation of biomass resources*. The Hague: [Dutch] Department of Economic Affairs.

Devaux, A., Torero, M., Donovan, J. and Horton, D. (2018). "Agricultural innovation and inclusive value-chain development: a review". In: *Journal of Agribusiness in Developing and Emerging Economies*, Vol. 8 No. 1, pp. 99-123.

Donovan, Jason; Franzel, Steven; Cunha, Marcelo, Gyau, Amos & Dagmar Mithöfer (2015). "Guides for value chain development: a comparative review." In: *Journal of Agribusiness in Developing and Emerging Economies*, vol. 5 No. 1, 2015, pp. 2-23.

Henike, T., Kamprath, M., & Hölzle, K. (2019). "Effecting, but effective? How business model visualisations unfold cognitive impacts." In: *Long Range Planning*, 101925.

Joyce, A., & Paquin, R. L. (2016). "The triple layered business model canvas: A tool to design more sustainable business models." In: *Journal of cleaner production*, *135*, 1474-1486.

Lundy, Mark; Amrein, Alexandra; Jairo Hurtado, John; Becx, Gert-Jan; Zamierowski, Nancy; Rodríguez, Fernando & Erika Eliana Mosquera (2014). *LINK methodology: A participatory guide to business models that link smallholders to markets (version 2.0)*. Cali, Colombia: Centro Internacional de Agricultura Tropical (CIAT), publication no. 398, ISBN 978-958-694-11.

Odegard, Ingrid; Croeze, Harry & Geert Bergsma (2012). *Cascading of biomass: 13 solutions for a sustainable bio-based economy - Making Better Choices for Use of Biomass Residues, By-products and Wastes*. Delft: CE Delft.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley, New Jersey.

Palmeros Parada, Mar; Osseweijer, Patricia & John A. Posada Duque (2017). "Sustainable biorefineries, an analysis of practices for incorporating sustainability in biorefinery design". In: *Industrial Crops and Products*, volume 106, pages 105-123.

Palmeros Parada, Mar, Asveld, Lotte, Osseweijer, Patricia & Posada, John A. (2018). "Setting the design space of biorefineries through sustainability values, a practical approach." In: *Biofuels, Bioproducts & Biorefining*, 12: 29-44.

Palmeros Parada, Mar; Asveld, Lotte; Osseweijer, Patricia & John A. Posada (2020). "Integrating Value Considerations in the Decision Making for the Design of Biorefineries." In: *Science & Engineering Ethics*.

Palmeros Parada, M., van der Putten, W., van der Wielen, L. A., Osseweijer, P., van Loosdrecht, M., Pashaei Kamali, F., & Posada, J. A. (2021). OSiD: opening the conceptual design of biobased processes to a context-sensitive sustainability analysis. *Biofuels, Bioproducts and Biorefining*.

Robaey, Zoë; Asveld, Lotte and Patricia Osseweijer (2018). "Roles and responsibilities in transition? Farmers' ethics in the bio-economy". In: *EurSafe News*, volume 20, no.1, June 2018 (pp.13-15).

Robaey, Zoë; Asveld, Lotte & Kinsuk Sinha (under review). "Inclusive biobased value chains: a means/goals approach to practice" Submitted to….

Van den Hoven, Jeroen; Vermaas, Pieter and Ibo van de Poel, eds. (2015). *Handbook of Ethics, Values and Technological Design*. Dordrecht: Springer.

von Schomberg, René, ed. (2019). *International Handbook on Responsible Innovation*. Cheltenham: Edward Elgar Publishing.

Zörb C., Lewandowski I., Kindervater R., Göttert U., Patzelt D. (2018). "Biobased Resources and Value Chains". In: Lewandowski I. (eds) *Bioeconomy*. Springer, Cham.

https://tudelft.nl/bt/ibis