Frans Hermans

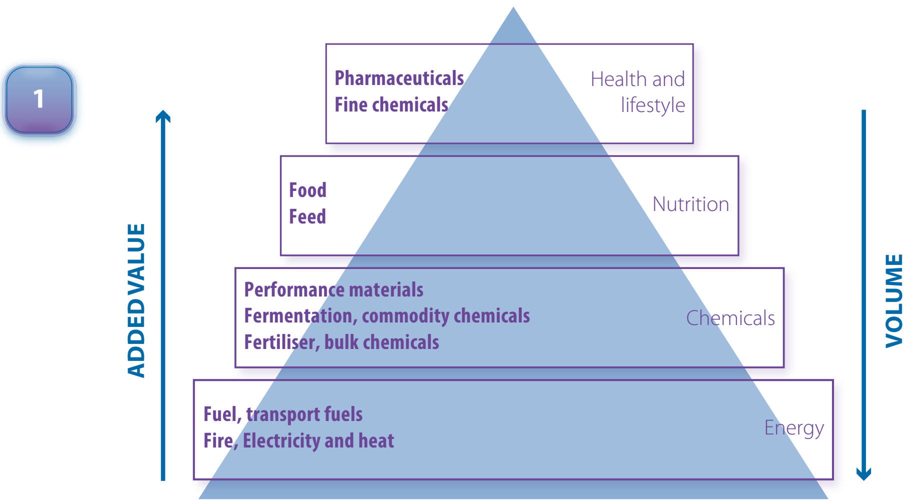
Classification of bioclusters

Introduction

This chapter looks at regional agglomerations that have specialised in bioeconomy: also known as biotech clusters. By definition, a bioeconomy obtains its building blocks **for materials, chemicals and energy from renewable biological resources**. As a result, a bioeconomy has the potential to promote sustainable development by contributing to a shift of energy generation away from fossil fuels, which would reduce global warming and simultaneously support innovations and regional and agricultural development (McCORMICK and KAUTTO 2013). At present, the expectations that bioclusters will play a key role in the development of the bioeconomy are so high that in many countries the funding of bioclusters plays an extraordinary role in bioeconomic policies (ZECHENDORF 2011, DIETZ et al. 2018). — However, to date, a generally recognised definition for a bioeconomic cluster has yet to be established and it is unclear what role such clusters can play during the transition to sustainability. Although sustainability is considered the central argument for active political promotion of the bioeconomy, this expectation has hardly been fulfilled (RAMCILOVIC-SUOMINEN and PÜLZL 2018). The purpose of this article is to structure the debate on bioclusters to develop a typology that shows the role of various types of bioclusters for sustainable regional development and the transition to a bioeconomy.

Development of a typology of bioclusters

In order to define bioclusters one must first have a general understanding of an industrial cluster. The most common description of a cluster originated from Porter (1990), and defines it as 'a geographically proximate group of interconnected companies and associated organisations (for example, universities, standards agencies, and trade associations) in a particular field, linked by commonalities and complementarities.' In the case of a biocluster, the 'particular field' is one or several sectors of the bioeconomy. This answers the question of what a biocluster actually is, however, only in part, since there are many varying definitions



of the term bioeconomy. Bioeconomy, bio-based economy, circular bioeconomy and the knowledge-based bioeconomy (KBBE), have all varying meanings with impacts on which sectors are then to be included in the bioeconomy concept. — The cluster typology presented here is based on the multi-level conceptualisation of an innovation system of Binz and Truffer (2017). They distinguish between the different types of knowledge used and certain product-specific key aspects of generating value. Several sectors are founded on formalised and codified types of knowledge (**STI**: Science, Technology and Innovation), while others are based on pure practical knowledge **DUI** (Doing, Using and Interacting). — The second axis focuses on the type of added value. Is the sector focused on cost reduction, standardised production methods or will the added value be created through specialisation and individualisation or customisation? The various strategies on generating added value form a central element for classification of various bioeconomic sectors and are often displayed in what is known as the **'value pyramid of biomass'** (ASVELD et al. 2011). The idea is that at the bottom of the pyramid, companies, who produce simply standardised mass products, are in competition with each other on cost price, whereas higher up in the pyramid the activities and products become more specialised and customised and generate increasing added value. — In **Table 1**, there are four types of bioclusters associated with typical examples of other cluster typologies such as the classic typology of industrial districts (MARKUSEN 1996) and the knowledge based taxonomy of clusters according to Iammarino and McCann (2006). — It is important to mention that biotech clusters are not static. During their life cycle they can further develop from one quarter to the next (refer also to BINZ and TRUFFER 2017). An important assumption in conjunction with this is that for the development of the full potential of a region, it is essential to move up the biomass pyramid to the highest value possible at premium pricing. Starting from the agricultural agglomeration, a biocluster could move in two

Table 1: Types of bioclusters

Valuation	Type of knowledge: DUI	Type of knowledge: STI
Standardised	**Agricultural agglomerations** **Examples:** glass house /horticultural clusters, wine clusters, intensive animal husbandry areas — Fragmented, atomistic network — Traditional agricultural innovation model with strong role of NARS* in innovation development — Cluster functions mainly for lobbying and sectoral representation — Local resource base is sector specific: crops and dairy more local inputs; animal husbandry more global inputs	**Green chemistry bioclusters** **Examples:** biorefineries, green chemistry (industrial biotech), paper and pulp clusters — 'Hub and spoke'-network with a centralised processing facility, often dominated by large incumbents (MNC—Multinational Companies) — Innovations sources are internal R&D and collaborations with universities — Cluster provides long term demand guarantee for agricultural products — Local resource base is sector specific: paper and pulp more local inputs; biofuel and bioenergy more global inputs.
Customised	**Marshallian bio-district** **Examples:** fashion, leather, wood construction and building — Tight and informal network built around family businesses — Innovation results from customer demands and interactions — Cluster provides image and branding — Medium reliance on local resource base	**Life-science clusters** **Examples:** pharmaceuticals and medicine (red biotech), cosmetics — Innovations sources from university knowledge and spin-offs — Global knowledge network, local financial network with venture capitalists — Cluster provides venture capital, knowledge spillovers and mentors — Low to very low reliance on local resource base

* NARS – National Agricultural Research System

directions. The first direction would be to establish the region as a brand. In such a scenario, a biocluster would move up the value-added chain in a process of diversification or 'niche formation' of the primary production thereby promoting local production through regional branding. State policies should concentrate in such a scenario on the regional brand formation and promotion of regional diversification, in particular through the settling of new SMEs (Small and medium-sized enterprises). This strategy is not always possible, however, and depends on regional peculiarities and the existence of a neighbouring city. The second option would be to try to form a 'green chemistry' type of cluster. This would entail a centralisation of production and could be an interesting option for agricultural regions with comprehensive primary production. State authorities should attempt to create a central processing plant in the region, depending on the product, it could also be a bio-refinery. The transition from a Marshallian biodistrict to a life-science cluster is seen as a shift from DUI to STI expertise. This would require investments in the regional scientific infrastructure, in particular in universities and other basic know-how that can contribute to adapting global knowledge to local circumstances and vice versa.

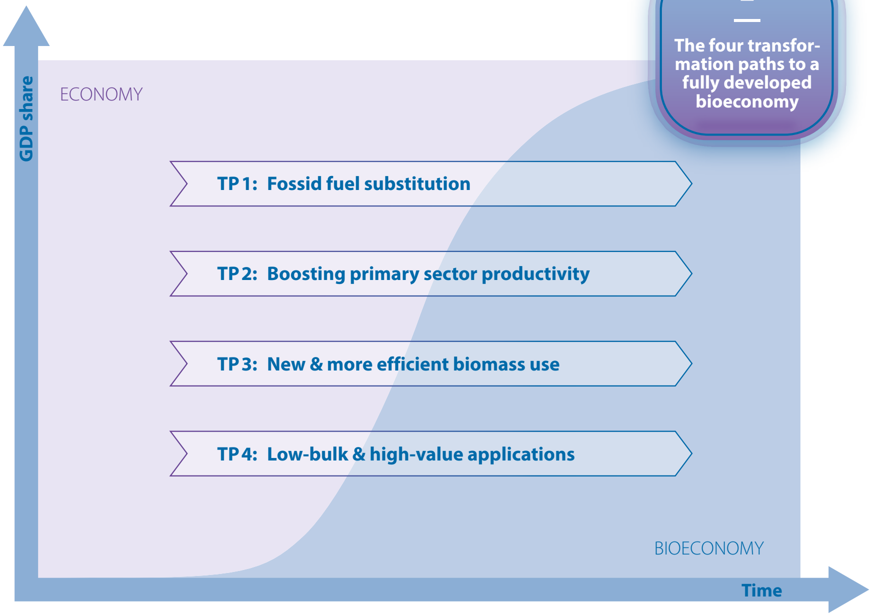
—The role of different types of biotech clusters in different transformation paths

The four types of bioclusters can each have a different transition pathway to a bioeconomy. In this connection, Dietz et al. (2018) identified four paths that a transformation process may follow. It is important to note that their pathways are defined from the supply side and as a result these four pathways follow the logic of scale increases of the activities within the cluster. Still, these pathways give a good starting point to think about the role of different types of bioclusters in the transition. refer to Figure 2

— It is important to observe that the four different paths of cluster formation are determined by the supply side (raw materials, production factors, human capital, etc.). Increasing scales or size advantages of certain activities decide which activities grow the greatest in the cluster during the course and drive a cluster-specific regional specialisation. Therefore, these paths provide a good starting point to contemplate the role of various types of biotech clusters for the transformation to a bioeconomy.

— For instance, agricultural agglomerations, and the boosting primary production pathway seem like a logical fit. The idea here is technological innovation leads to increases of productivity in agriculture and forestry that can open up new production methods or locations. This transformation pathway follows the logic of the Green Revolution with its focus on the agro-industrial model of scale increases.

— Green chemistry clusters could potentially follow the fossil fuel substitution and conversion pathways. This pathway focusses on process innovations and conversion of new and (more) efficient uses of biomass comes to the foreground. This pathway looks at the processing of biomass and the most efficient use of it in downstream sectors. Biotechnology (enzymatic synthesis) can play an important role in this pathway. — For the high-tech life-science clusters, but also to some of the Marshallian biodistricts focussing on fashion, leather and design the pathway labelled 'low bulk, high value applications' seems to be most appropriate. The difference between them is that in the high-tech life-science clusters, the **five biological principles** (cell theory, genetics, evolution, homoeostasis, the law of thermodynamics) are used more or less independently of the biomass streams are used. The corresponding transformative processes potentially result in cheaper and more environmentally friendly production methods or completely new products. In the Marshallian biocluster the link to the primary product is more pronounced. Especially in fashion districts, parts of the production process (the design) can be done in Europe, while actual production is done somewhere in Asia.



2 — The four transformation paths to a fully developed bioeconomy

Discussion and conclusions

The here presented typology of bioclusters is a work in progress and depends on a review of some existing cluster typologies combined with an analysis of some of the characteristics of different sectors of the bioeconomy. As such, the here presented typology contains a number of 'archetypes' of bioclusters. In reality bioclusters probably contain a broad mix of sectors, some of which are not connected to the bioeconomy at all (for instance ICT). — In a similar vein it has to be noted that the environmental and social implications of some of the four transformation pathways is often contested. The classic example here are the biofuel policies in the EU and US that have led to increased demand for bioenergy, with direct and indirect effects on land use worldwide depending on land availability. The negative environmental consequences of the first generation biofuels made this policy controversial and combined with lower prices of fossil fuels due to the increasing supply of shale gas from fracking has led to calls away from biofuels and more towards policies aimed at the manufacturing of bioplastics (CARUS et al. 2011). Therefore, issues like the rebound effect, geographical and temporal negative trade-offs in the forms of (in)direct land use and climate change and social and economic dependencies on regional primary production need to be monitored for their potential negative repercussions for the sustainable development at regional, national and international levels. A more detailed and refined view on these effects, not only inside but also outside of the clusters and the different effects across different levels is necessary and this is something we will work on in the future within the **TRAFOBIT** group.

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Figure 1 Value pyramid of biomass © Own presentation according to Asfeld et al. 2011
Figure 2 The four transformation paths to a fully developed bioeconomy © Own presentation according to Dietz et al. 2018