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Article

A Qualitative Investigation of European Grain Legume Supply Markets through the Lens of Agroecology in Four Companies

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Abstract: Four companies in Europe were chosen as case studies using an information-oriented selection procedure on the basis of their location, processing equipment and size, and through the adoption of a "maximum variation" approach. The purpose was to investigate how legume processors of various sizes and in different locations in the European protein legume market are working to increase their market share within the paradigm of efficiency gains from agricultural specialisation and trade in order to improve both food availability and security. After identifying company typologies and characteristics, the company case studies along the legume value chain were investigated. The analysis revealed that the supply market for grain legumes is expected to grow rapidly, and the various processors are increasing their market shares in terms of product type and geography. Based on the principles of agroecology and levels of food system change, the companies were found to be adopting promising business strategies, but are not disrupting the competitive patterns among existing European legume supply companies and food consumers that dominate the current regime. System change is far from taking place. However, conventional perspectives are being challenged and new ways of operating are being developed, indicating that a significant transition can be initiated that would move legumes away from being a niche sector, demonstrating to legume processors and consumers in the regime that there is an alternative and more sustainable pathway for the future, possibly stimulating larger-scale initiatives.

Keywords: agroecology; businesses; grain legumes; sustainability; transition

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1. Introduction

In light of the world's increasing population and the insufficient food supply, it is evident that there will be a global protein crisis [1,2]. Grain legumes such as yellow pea (*Pisum sativum*), chickpea (*Cicer arietinum*), and faba bean (*Vicia faba*), which are produced throughout Europe, can become an important ingredient in future diets with less meat and more vegetables and plant-based, protein-rich products. Grain legumes have many functional and nutritional properties both as feed and food, providing health benefits for changed human diets and animal fodder planning [3–5]. Numerous ecosystem services (ESS) can be introduced to cropping systems by their unique symbiotic atmospheric N_2-fixation capacity [6–8], potentially decreasing global warming since nitrogen fertilisation is responsible for almost half of all agricultural greenhouse gas emissions [9], break-crop effects in cereal-rich rotation reduce pesticide needs [10], and subsequent crop effects cut both fertiliser and pesticide use [11,12].

European agriculture allocates just 1.5% of arable land to grain legume crops, compared with 14.5% worldwide, and there is a 70% protein deficit primarily for livestock feed, 87% of which is met by imported soybean and soymeal [13]. This development is also connected with commercial breeding selection strategies, public subsidies, and food systems favouring an increase in cereal returns [4,14,15]. A second green revolution might be required to ensure food and nutritional security in the face of global climate change [3]. In addition to giving better consideration to the pre-crop value, more genetic and agronomic

improvements in legume cropping, supportive market developments, and policy support are required if Europe is to exploit the environmental benefits offered by these species [16]. Even though legumes cultivated within the EU can substitute imports of soybeans from countries in South America, the US, and China, which is the largest supplier to the EU [17], less attention has been paid to the business models being attempted by existing and new suppliers on the legume market within the EU.

Current agricultural practices are facing numerous sustainability-related challenges [18–20], such as ensuring food security while reducing climate change risks. Legume crops could deliver multiple services in these areas. Agroecology is being promoted as a potential future model [21–23] offering pathways to transform agricultural and food systems, as well as make greater use of biological interactions and natural processes than synthetic and technology-based inputs [24–26]. The concept of industrial ecology, which emerged in the 1980s, applies the same understanding of "systems" and "nature", where industries mimic a "natural system" in which no resources are wasted, but instead are utilised within other industries as new resources [27–29]. In addition, the association Agroecology Europe (www.agroecology-europe.org, accessed on 15 March 2022) stresses the importance of agroecology as a social and political movement, defending smallholders and family farming, farmers, and rural communities, as well as encouraging food sovereignty, local and short marketing chains, a diversity of indigenous seeds and breeds, and healthy, high-quality food.

The concept of agroecology is defined as "the application of ecological concepts and principles to the design and management of sustainable agro-ecosystems" [30] (p. 17) and offers ecological services, such as climate change mitigation, groundwater protection, and biodiversity conservation [20] to fight, for example, the decline in soil organic matter [31] and biodiversity [32] due to anthropogenic factors. Agroecology, according to Silici [33], is a normative framework to assess how to conduct planning, utilise resources, and manage fields and landscapes [33]. One of the most widely used frameworks for formulating transitions in agroecology is the five-level transition path approach towards more sustainable food systems developed by Gliessman [21]. This conceptual framework classifies three levels within farm boundaries (optimisation of resource use efficiencies (Level 1), substitution of conventional practices (Level 2), and redesign of agroecosystems (Level 3)) and two levels beyond farm boundaries (connection between production-consumption (Level 4), and restoration and protection of the earth's life support systems (Level 5)).

Despite trying to promote legume cultivation in Europe, production remains unsatisfactory [2,13] due to public policies and market dynamics that promote cereals instead [4]. Obviously, farmers grow crops that are economically viable and fit for the identified actors [16]. Incentives for growing more legumes must include value chains and markets, the environment, and social aspects [22] connected to interrelated factors, such as dominant intensification production practices [5,20]. This study investigated four contextualised grain legume company processors across Europe, with different sizes and different process equipment setups to challenge the dominant research focus on legumes (Gliessman's Levels 1–3) moving into the food system and societies in which fast-developing niche grain legume supply markets are embedded (Gliessman's Levels 4–5). The area of value chain opportunities and barriers is currently under-researched. This study's focus on technology and company-led solutions to drive the necessary transitions, plus growing support from civil society and possibly empowering the numerous different actors within dominant global food systems based on a common understanding and a joint interest in collaborating with civil society, may empower a diverse set of actors both inside and outside of the dominant global food systems.

The aim of this study was, therefore, to investigate how legume processors operate within their specific social and economic contexts. The focus was on niche regime interactions that play a key role in a transition's "take-off" phase. The objective is to contribute to filling the knowledge gap concerning today's European legume supply market and legume

processors' plans and ambitions for potential market expansion, as well as to examine the business strategies adopted by the case study companies.

2. Materials and Methods

This section outlines the qualitative research undertaken and the methodologies applied toward investigating and shedding light on four selected European legume processors, and hence provide novel knowledge about potential future company development planning in order to adapt to the anticipated expansion of the legume market.

2.1. Investigation

Using information-oriented selection, four legume processors were selected as case studies from partner networks within the LegValue project (http://www.legvalue.eu, accessed on 8 January 2021), firstly on the assumption that their involvement in the project means they would be willing to share information and, secondly, based on their process equipment setup and size differences (Table 1), and including their location and agricultural sector profiles (Table 2). A "*maximum variation*" approach was adopted to obtain knowledge about the significance of different circumstances for the case outcome in order to gain important information and, at the same time, be able to experience variations in the *nature* of the cases analysed [34].

Each of the four cases was investigated during company visits, where interviews with company managers, photographic documentation, observations, and dialogue with additional staff associated with the plants were conducted. This provided empirical data for writing summaries and obtaining feedback on the collected data and additional information from the interviewees through an iterative process [35,36]. A semi-structured interview guide was used for all four cases to provide an interaction between prior theoretical knowledge, and experience and observation during visits to the actual case sites. The first author of this paper, an experienced senior scientist, had full responsibility for all contacts and interactions with all the interviewees. The following topics were explored during all the visits: (i) company background and legume type; (ii) the company's current position within the legume value chain; (iii) technology adaptation; (iv) future markets and business strategies; and (v) obstacles and opportunities for increasing market shares. From experience, the authors are aware of how such interactions refine, question, and alter pre-assumptions. Based on the comprehensive qualitative empirical material gathered in accordance with the guidelines of Collier et al. [35], typologies of the individual cases are produced forming concepts, refining measurements, exploring dimensionalities, and organising explanations given by case managers. Thus, the analytical strategy, in response to the empirical data collected, was to elucidate interview guide headline statements following the guidelines of Gliessman [21] to produce overviews as the basis for the fourth and fifth final in-depth analytical stages.

2.2. Case Selection

Case studies are a useful method of data collection in situations where rare phenomena are being investigated [36], such as the limited number of grain legume supply companies currently in the EU. However, in the present study, much of the empirical data collected were considered confidential by the individual case study managers, diluting the more specific and detailed information for further analysis. This means that the companies are not only categorised (Table 1) by the estimated number of employees, but also by their characteristics, such as an assessment of the quantities of legumes being processed (no data were provided during the interviews), the number of retailers involved in distributing the legumes, and the technology level of the machinery used to process them (Table 1).

Table 1. Categorisation of companies by selected characteristics.

	Norway	Germany	Portugal	Denmark
Quantities of legumes processed [1]	High	Medium	Medium	Low
Number of employees [2]	Medium	Few	Few	Few
Number of retailers [3]	Many	Few	Few	Few (one)
Technology level	High	Medium	Medium	Low
Further refining of legumes, e.g., flour	Yes	Yes	Yes	No
Seeking large-scale market expansion	Yes	Yes	No	No
Final categorisation	Large	Medium	Medium	Small

[1] For reasons of confidentiality, exact figures could not be obtained, and indicators were based on the experienced senior scientist's estimation of processing equipment capacity during company site visits. [2] For reasons of confidentiality, European Commission definitions were used where: (i) fewer than 250 employees defines SMEs [37], (ii) 0–100 employees defines "small businesses", 100–250 employees defines "medium-sized businesses", [38] and more than 250 employees defines "large businesses". [3] This is confidential information; therefore, the authors estimated the number from the extensive information provided.

The Norwegian case study stands out because it processes very large amounts of legumes using highly advanced technology, but has a relatively small number of employees. The German and Portuguese companies are in the medium category, with many fewer legumes being processed compared with the Norwegian case, but operating different market strategies. The Danish company is small, with much lower quantities being processed and a relatively simple technology level.

Given the backgrounds of the various case study countries, different agricultural profiles must be included (Table 2) in order to provide a contextualised understanding and analysis across European countries and regions. On a European scale, there are around 10.5 million farms, the vast majority of which (95%) are classified as family farms [39]. Around 80% of the workforce input in the sector is provided by family members, with commercial activities undertaken on around 60% of the total utilised agricultural area by animal production and arable farming.

Denmark is the country with by far the highest percentage of arable land. Germany and Denmark have the largest farms, followed by Norway and Portugal. Livestock density is lowest in Portugal and highest in Denmark. Rotations are dominated by perennial pastures for fodder in Norway, whereas annual cereal production, predominantly also used for fodder purposes, covers more than 50% of arable land in Germany and Denmark. In Portugal, more vegetable crops and other specialty crops are cultivated. Non-food crops are most extensive in Germany and are associated with the country's biogas markets.

Table 2. Agricultural sector profiles in case study countries, based on selected references shown in square brackets.

	Norway	Germany	Portugal	Denmark
Population density (persons per km^2) [40,41]	14	225	112	135
Arable land (% of total) [42,43]	2.1	33.7	10.7	56.6
Total number of farms [39,44]	40,000	276,000	259,000	35,000
Average size of farms (ha) [45,46]	22	42.7	7.6	52.4
Livestock density (unit/ha) [47]	1.26	1.1	0.6	1.6
Cultivation of cereals, non-food, fodder, and other crops (% of total) [48]	36, 0.2, 63, 0.8	55, 12, 13, 20	29, 1, 32, 38	60, 7, 24, 9
Animal husbandry: cattle, horses, pigs, sheep, goats and poultry (% of total) [47]	48, 2, 15, 20, 0, 15	49, 1.5, 36, 0.5, 0, 13	50, 1.5, 20, 10, 1, 17.5	28, 1, 66, 0.5, 0, 4.5

2.3. Company Case Study Typologies

Inspired by the work of Collier et al. [34], which emphasises the values of high standards of rigour and careful qualitative measurements, "conceptual" or "descriptive" typologies were formulated in order to refine empirical material exploring the characteristics of the company case studies. The aim was to help readers memorise information about the different companies and highlight their differences—or nature as legume processors—within local, national, European, and even global markets. The starting point for this was a semi-structured interview guide, which steered the conversation, but also prompted interviewees to introduce issues that they felt were important, not necessarily just implementing technical solutions for growth, but also meeting social and/or political challenges within their actual social, cultural, and environmental contexts. The ambition was to topologise grain legumes as part of a socio-technical complex system [49]. Each headline in the following subsections is the label given to their company by the interviewees themselves.

2.3.1. The World Is My Oyster

The Norwegian company is a large organisation that focuses on the global market for various types of legume products, both as food and fodder. The company was originally established as a fish fodder company, targeting the Norwegian salmon industry, and later expanded into pet food. It now sees great opportunities for legume proteins as food ingredients. A further expansion of the markets is thus based on the advanced and continuous refinement of legume products, and includes participating in research projects and identifying new routes into global markets. Thus, this company is targeting the whole global market. It processes yellow pea supplied by other countries, currently primarily Denmark and the Baltic countries. The peas are sent from Denmark to Norway and back to Denmark for further refining, and then distributed on the global market. Transportation routes, distances to retailers and knowledge about end customers are not regarded as important.

2.3.2. Bigger Is Better

The German company case study is a medium company that supplies faba beans for food, currently primarily to the Middle East. The company has a clear strategy for increasing its size and market shares beyond the traders and consumers in that part of the world, placing a special emphasis on other global markets, such as North Africa, as well as on European markets in the very near future. The European domestic market is regarded as too small for the expansion targets set by the company. Thus, it is planning to grow by increasing the volume of legumes it processes, operate in new markets, and offer new, more highly refined, products. The faba beans it currently processes are from local German farmers, but the company is interested in purchasing faba beans from outside Germany as well in order to increase its gross revenue as quickly as possible and hence exploit opportunities for larger market shares in future. However, the company has previously attempted to import from Poland, but this was unsuccessful because several crop quality parameters (e.g., crude protein, physical purity, shape/size, and physiological vigour and stamina) were not met.

2.3.3. Southern Comfort

The Portuguese case study company is a medium-sized organisation that supplies chickpeas for food primarily on the domestic supply market. Chickpeas are produced by three local farm cooperatives and individual farmers and delivered to the production facility in an industrial area in Evora, where they are processed further. The chickpeas are cultivated conventionally. The company's strategy is to expand its market share just in Portugal, increasing the volume of chickpeas by concluding contracts with local farmers and introducing new refined products to the market using grinding and air separation, and similar non-high-tech technologies. The company also hopes to increase its market share soon by supplying certified chickpea seeds to Portuguese farmers and to other farmers,

most likely in southern Europe. Finally, organic legumes will also be a part of the company portfolio in future, but the expected volume is low due to Portuguese farmers mainly farming conventionally.

2.3.4. Local Is Beautiful

The Danish small-scale legume business is situated on a larger estate, where arable cropping (1000 ha + ~200 ha leased land) is integrated with pig farm buildings that are rented out (600 sows, ~20,000 weaners per year and 5000 finishers per year), and the manure they produce is used in place of artificial fertilisers. The estate also receives 3000 tonnes of manure from a nearby turkey production facility. The estate's business has grown in the last few decades, and now comprises conference facilities, a restaurant, a hotel, and recreational facilities such as tree climbing and wooden cabin rental, as well as the renting of land to hunting consortiums.

Several food grain legumes are produced, such as chickpeas, lupines, and lentils, in smaller amounts, with a focus on the development of local farm networks and alternative food chains and an emphasis on locally cultivated and sustainable crops. Faba beans for feed are produced on a large area (>70 ha) of the estate. The company will grow mainly by expanding local networks, with the estate purchasing legumes from other farmers and selling them to a small local food service retailer, who will then distribute this produce to local and regional restaurants, etc., in Denmark. However, as the market for legumes gradually grows, direct selling to retail chain(s) is regarded as an option, still facilitated by the same local retailer. Currently, the company is focusing mainly on local farm networks and its relationship with the estate's restaurant, hotel, and conference customers, who want organic and sustainably cultivated farm produce on their plates. The main emphasis is not to expand beyond the needs of its own kitchens or deliver very large quantities of legumes to various retailers.

2.4. Analytical Framework

In this study, grain legumes are embedded in agroecology and regarded as an important part of the redesign of food systems, from the farm to the table, with the goal of achieving ecological, economic, and social sustainability. Thus, the [21] five-level transition approach of Gliessman (Table 3) offers a conceptual link for classifying agrifood system changes based on the relationship between grain legume suppliers and other actors in the system. The first three levels concern changing farm management, with the two additional transitional levels addressing elements beyond the scope of farm management. The fifth level not only requires adjustments to practices or markets, but also calls for profound changes in the consolidation of power and values in global food industries. In the Results and Discussion sections of this paper, a greater emphasis is placed on levels four and five because this is where genuine transitions can be made. However, in order to analyse and discuss the European supply market for legumes using the empirical data from the four case studies, the 'nature' of each company case study is investigated by examining the individual companies' core business, future plans, and possible obstacles in the legume market (Section 3.1). A brief summary of the companies' characteristics follows (Section 3.2), before applying the principles of agroecology provided by Silici [33], but in accordance with Gliessman's [21] transition levels.

Table 3. Different levels or steps with a gradually more profound impact on agricultural practices and need for societal changes. Modified from [21].

	Principle	Actions
Level 1	Increase the efficiency of industrial and conventional practices to reduce costly, scarce, or environmentally damaging inputs.	Help farmers maintain or increase production output.
Level 2	Transition to replace external input-extensive agricultural practices with more sustainable and environmentally friendly strategies.	Adaptation and modification of alternative practices from, e.g., organic and biodynamic farming and conservation agriculture.
Level 3	Redesign the agroecosystem to combat the root causes of Levels 1 and 2, creating beneficial ecological processes locally.	Reintroduce farming practices, such as diversified rotations, multiple cropping, agroforestry, and symbiosis between agriculture and animals.
Level 4	Re-establish a more direct connection between those who grow food and those who consume it.	Form new local communities of growers and consumers for alternative economy models and food culture.
Level 5	Build a new global food system that is not only sustainable, but helps restore and protect the earth's life and support systems, on which we all depend.	Global-scale initiatives beyond the food sector, re-thinking how we relate to the earth's resources and to our basic values, beliefs, and ethical views.

3. Results

In the following section, the core business of the case study companies is presented, as described in Section 2.3, followed by a brief summary highlighting the transition in the legume supply market.

3.1. Company Case Study Investigation

3.1.1. The World Is My Oyster

The *core business* of the company is to make pet and fish feed and ingredients for the food industry based on dried yellow field peas. The company exports all over the world to retailers and does not know its end customers, except for national fish/trout-breeding companies. In the factory, the pea is first milled and de-shelled, and the fibres extracted (Figure 1). Subsequently, dry fractionation takes place via air classification, separating the protein and starch. The protein is used for pet feed and currently also for human food. The starch is used for pet food and fish fodder (it still contains 10–12% protein). In addition to the company in Norway, a new company called NISCO has also been established in Nakskov, on southern Zealand in Denmark. At this plant, the yellow pea protein, which is transported in large bags from Norway by truck, is extruded, packed, and exported to various countries as a food ingredient, e.g., to Spain, where the extruded pea is mixed with minced beef and used for ready-made burgers.

The company's *future plans* are to make products for the food industry that customers can recognise and enjoy. There is an emphasis on mixing legumes with meat, for example, and the company is undertaking research with the Technical University of Denmark (DTU) on "fibre spinning". This involves spinning protein legumes into a thread, making it easier to mix them with other food ingredients. The company would also like to extract more protein from the starch than they are currently able to achieve. New business partners could therefore be companies that have the capability to do this, e.g., potato companies in Denmark. The remaining protein can be extracted by wet fractionation; however, a process of this kind is resource intensive, and therefore is of little interest to the company because it is seeking to use energy efficiently and produce GMO-free and allergen-free products. Finally, the company is planning to increase production dramatically within the next few years. Today, 95% of its products are targeted at the feed industry, and just 5% to the human food industry. Within the next 10 years, the company plans to reverse these figures owing to new and major trends on the market. *Possible obstacles* here include its dependence on primarily imported legumes for the production of various legume products, which makes the company vulnerable if these countries find other markets or start supplying their own

markets rather than exporting. Furthermore, the energy-intensive protein concentration processing using air separation, e.g., is sensitive to energy price increases.

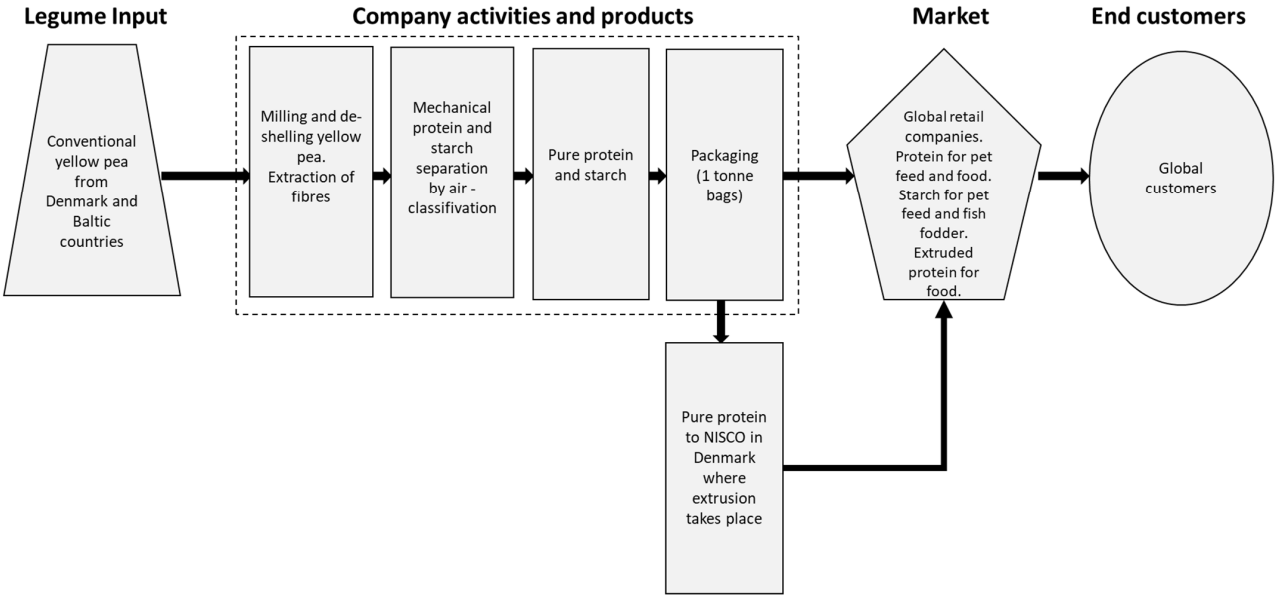

Figure 1. A conceptual model illustration of "The World Is My Oyster" company, located in Norway with a smaller processing facility in Denmark.

3.1.2. Bigger Is Better

The *core business* of this start-up company, which has been running for four years, is to process IFAS-certified (international food quality standard) faba beans at the company's plant in western Germany. The faba beans are sorted by different qualities and sizes, and the company also produces peeled and split beans. It is highly dependent on good business relations and prioritises having an almost personal relationship with its customers. As this is regarded as a prerequisite for success, it also means spending a large amount of time visiting retailers in the Middle East and Africa, where many of its end customers are located. However, on occasion, the company has to accept unpaid faba bean shipments due to misunderstandings that occur in intercultural business communication, infrastructure deficits, and trade barriers that may arise in a broken supply chain. This is almost catastrophic for the company if/when it happens (Figure 2).

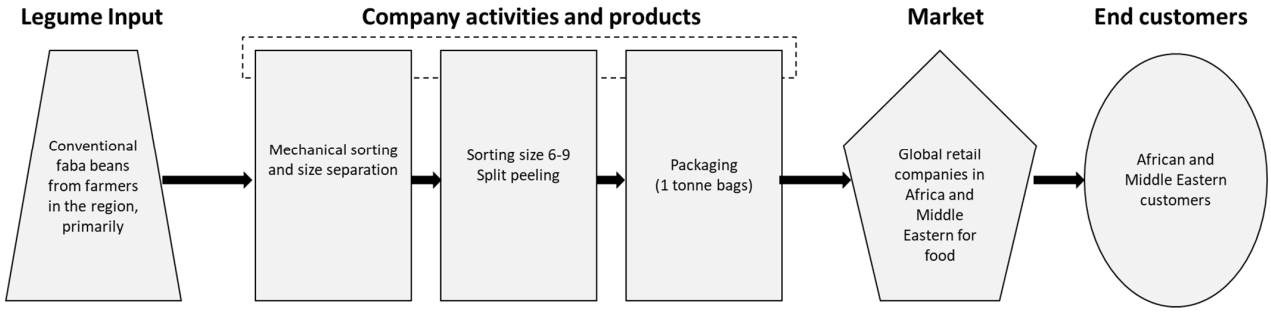

Figure 2. A conceptual model illustration of the "Bigger Is Better" company, located in Germany.

The company's *future plans* are to establish a joint venture with a large-scale milling company in Germany to produce legume proteins as a flour product to mix with other food ingredients. Thus, the company will have several products that it can sell on the market, including the European market, in its effort to increase its market share. The company is foreseeing a fast-growing and -changing market, with an increased focus on and

opportunities for plant protein food markets, vegan movements, and processing industries that require meat substitutes for a variety of final products, such as cake ingredients, meat substitutes in sausages, and the crispy coating for fish fingers, etc. In general, the company sees great opportunities for the future as far as faba bean markets are concerned; it hopes to expand and be a part of this transition in food production and consumption within Europe and more local markets.

Based on personal experience, the company does not see *possible obstacles* for the legume market from large-scale competitors, but rather from its own capacity and limited management skills of operating within the framework of small and medium-sized enterprises (SMEs). Principally, it is seeing skill shortages at every level in the hierarchy of SMEs and runs the risk of missing out on the huge market potential. With the appropriate skills, the hiring of new staff, and employee upskilling or re-skilling through training, the company believes it could penetrate markets more easily and quickly than is the case today. The fact that there are large players and major competitors primarily delivering soybeans, but also other grain legumes, to the EU from Brazil, Argentina, the USA, and Canada is only partly seen as a threat by the company. This is because the European legume market is currently GMO-free. However, if this changes, major players could enter the EU market relatively quickly and easily. One example of this is provided by Cargill, which is very powerful on the American, Canadian, and Russian markets, as well as in countries in South America or those without GMO restrictions, potentially encouraging Cargill and others to move into their markets or even take them over. Another major obstacle highlighted is climate change and the rise of unforeseen weather patterns, increasing both production risks and transport challenges. If the current climate of several months of droughts in the southern parts of Europe becomes more frequent, this will represent a threat to the business.

3.1.3. Southern Comfort

The domestic *core business* is chickpeas, sorted into sizes 6, 7, 8, and 9 by large filters, and used for different purposes depending on their size. It also produces split peas, usually used for making soups etc. The chickpeas leave the company in 1-tonne bags and are sold on the retail market; from there, they go to Portuguese customers. Some of the residues, such as shells, broken chickpeas, and weed seeds, are separated and sold or given away as feed for sheep or dairy cows to local farm cooperatives, with whom the company is already collaborating.

Its *future plans* are to stimulate an increase in chickpea production by Portuguese farmers to boost the factory's volume, but the company realises that it will not survive with this business strategy alone. Thus, in future it will also seek to refine the chickpea further itself by making flour, for example, which can be used as a food ingredient. The company will also try to include organic chickpeas in its portfolio in future, but it does not believe that there is great potential here, as the farming communities are typically conventional. In addition, it is also involved in chickpea breeding, and is working to get its own chickpea seeds into the EU's established system of granting intellectual property rights for new plant varieties, called community plant variety right (CPVR). It believes that there is a growing market for direct sales to farmers in Portugal and southern Europe in general, and France in particular (Figure 3).

Possible obstacles are the supply of chickpeas to Portugal from Argentina, for example, which are very cheap and meet European quality standards. The Argentinian produce has the advantage of large-scale production and economies of scale in Argentina, with which the farmers in Portugal cannot compete. This is reinforced by current low prices for farmland in Argentina and the appearance of aggressive counter offers during negotiations. In addition, many chickpea farmers in Portugal are currently tempted to convert their farmland to cultivate olive trees and almonds, as large commercial companies are offering them favourable deals for conversion. Good quality soil is thus taken out of the chickpea market to instead cultivate perennial export crops, which is put forward as a major problem for domestic self-sufficiency and independence.

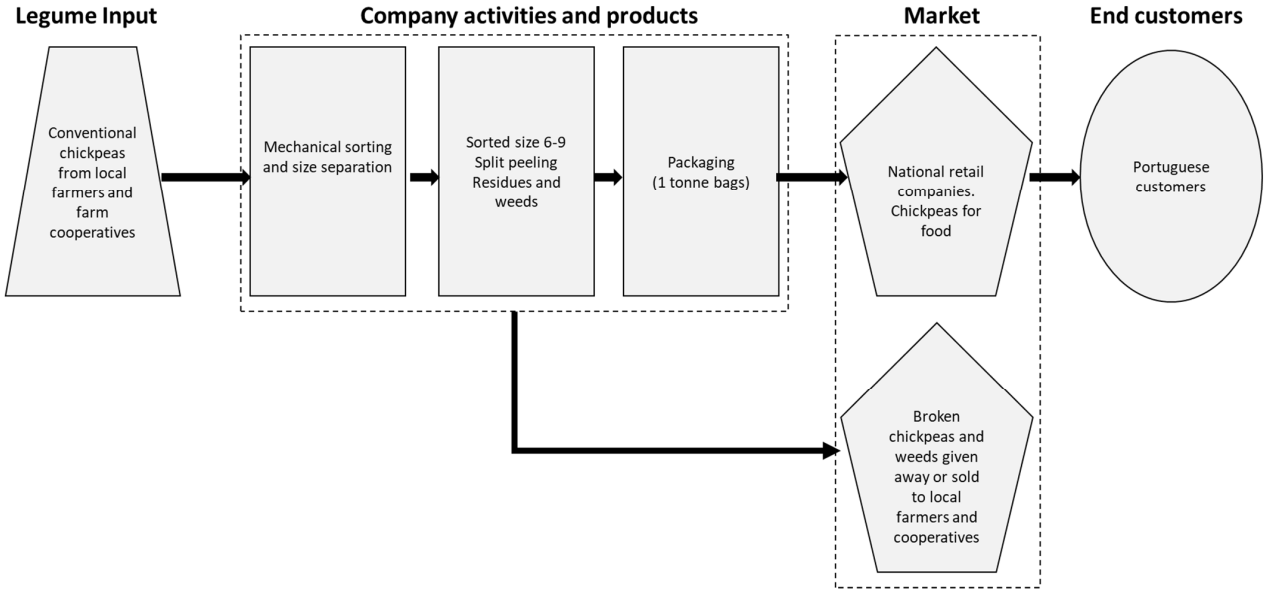

Figure 3. A conceptual model illustration of the "Southern Comfort" company, located in Portugal.

3.1.4. "Local Is Beautiful"

The *core business* specialises in chickpeas and yellow lupines, used directly for food. Both species are rare in the Danish agricultural and food landscapes. Creativity among chefs in the estate's kitchens is directly used as an indicator of future grain legume cropping. Yellow lupine, which looks like a small bird's egg with its maculated spots when served on a plate, is used in restaurant dishes as a garnish, and chickpeas are used in various dishes from salads to a variety of vegetarian burgers and similar foods. The development of new dishes is ongoing (Figure 4).

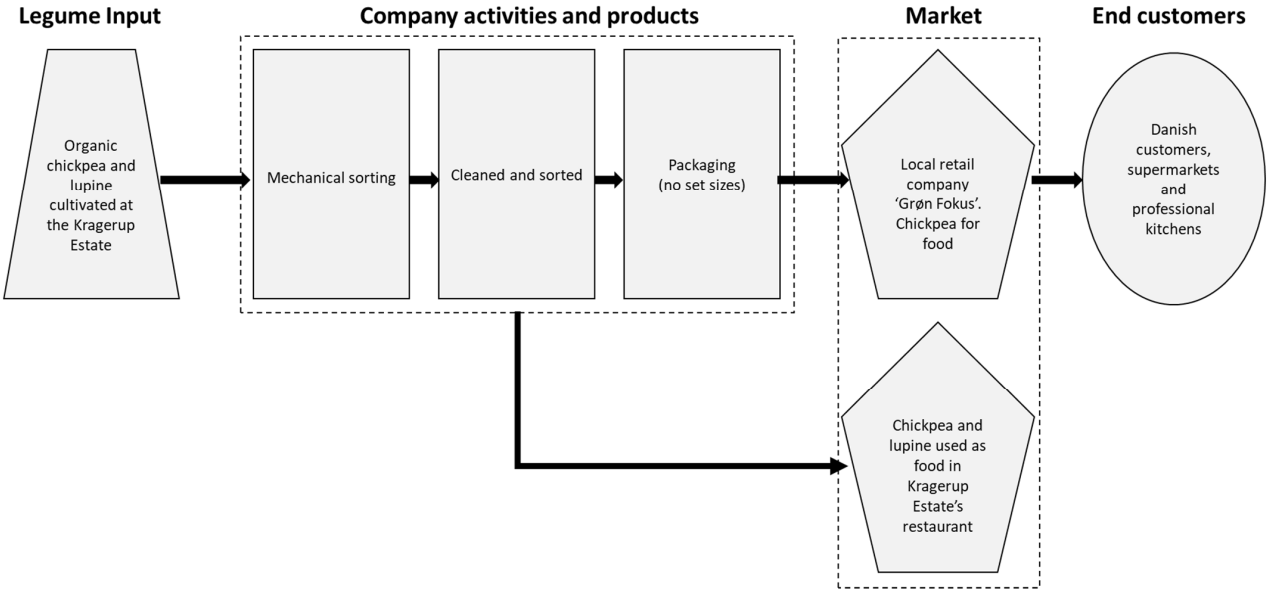

Figure 4. A conceptual model illustration of the "Local Is Beautiful" company, located in Denmark.

Cultivation of lupine originally began on the estate because yellow lupine contains a substrate that reduces pests and diseases entering the main crop when grown in borders around the field. This decreases pest pressure and reduces the need for chemicals. Most of the chickpeas, which are rarely cultivated in Denmark but used to be grown in this particular area of Denmark about 50 years ago, are sold to a local retail company called

"Grøn Fokus" (Green Focus). This company supplies customers further along the supply chain with organic leguminous proteins, which is a new business for this company. The estate has purchased two low-cost cleaning machines from Poland, which have been modified to rinse and clean the legumes to 100% purity and provide high-quality final produce for sale.

The *future plans* on the estate are to increase the cultivation, and thus, the volume, of chickpeas on the farm for onward sale to the single retailer "Grøn Fokus". There is also a plan to buy additional chickpeas and other grain legume crops from local farmers, process them on the estate (sort, clean, and bag), and then sell them through local farm shops. This will facilitate the processing and sale of even small deliveries of chickpea from nearby farmers, which would be difficult for the individual local farmer to achieve.

The *possible obstacles* to the estate achieving these goals are the (still) limited/immature market for food legumes in Denmark, and the limited knowledge among consumers regarding the various benefits of legumes, not only nutritionally, but also when it comes to ESS. Thus, the estate has established that people have limited knowledge about ESS and do not recognise its benefits as far as the soil, local environment, and farming are concerned. According to the estate, it is necessary to educate people more about nutritional dishes made from legumes, as well as increase their knowledge about the production and consumption of raw materials.

3.2. Summary of Characteristics

Company size & technology: The larger the company, the more advanced its technology seems to be, ranging from advanced air classification technology and the separation of starch and proteins seen in the Norwegian company, to traditional sorting and cleaning technologies adopted by medium-sized companies (Germany and Portugal), to the quite simple and low-cost machinery used in small companies (Denmark) (Table 1). In this study, the technology level determines the target markets—local, national, or global. The medium company in Germany would like to focus more on global markets in selected parts of the world.

Legume supply trends: A trend identified among the companies to meet the growing demand on European markets is to produce flour as a supplement to their traditional legume produce. Thus, flour is produced—or will soon be produced—by all of the companies, except by the small Danish company. The Norwegian/Danish company even produces an advanced extruded product with no bitter tannin "side taste", which normally prevents a large percentage of legume flour from being mixed with food produce, e.g., minced meat. Another trend observed is the emphasis on food products, when legumes in many European countries have traditionally been used as animal protein feed. A greater emphasis is now placed on food, with feed appearing to be the second priority. The production of legume flour, as described above, is thus an outcome of this trend, with its use as a food ingredient in different qualities and quantities.

Future market opportunities: All of the legume company case studies anticipate a growing demand for local legumes and plant-based proteins in European, national, and even local legume markets. The Norwegian company already has a well-established global market share. Organic legume production is regarded as one way to increase/maintain market share. A common feature for all of the companies is even tougher competition from large-scale multinational legume suppliers, along with the impact of climate change on production and logistics.

4. Discussion

This section contains a discussion and cross-analysis of the four case studies using Gliessman's [21] five levels (Table 3), focusing on the companies' contributions to sustainability. These are situated in, for example, (i) the European Green Deal, which aims to achieve significant reductions in carbon emissions; (ii) the Farm to Fork Strategy [50], which is at the heart of the European Green Deal [51], with objectives to ensure that food

and nutritional security are not compromised for current and future generations; (iii) the Biodiversity Strategy [52], which sets specific goals for the EU's long-term nature conservation policies, influencing Farm to Fork strategies on adaptation to climate change, among other difficulties; and (iv) the Common Agricultural Policy (CAP) [53], which was launched in 1962 with a cost-effective ambition to keep the rural economy alive, while for the new 2023–2027 period, it places an emphasis on sustainable development, the preservation of natural resources, and the need to ensure generational renewal. Potential national and even regional institutional and societal changes influencing these company case studies will only be included to a limited degree. Nevertheless, considering the multiple benefits of grain legumes, as far as their functional and nutritional properties are concerned [3]—including ESS within and outside cropping systems [8] and a reduction in global warming [54]—economic growth might be decoupled from resource usage, as mentioned in the European Green Deal [51]. Through the lens of agroecology, this study attempts to look at the development of the agrifood system from a supply market perspective in order to explore the root causes of the lack of change. Thus, the qualitative data research approach is relevant for more inclusive transitions [51], as well as for prioritising social aspects addressing regions, industries, and workers. The sole emphasis of Gliessman's [21] fourth and fifth levels underlines the ambition to challenge the postulation that farm system optimisation (Levels 1–3), without value-chain understanding and interactions, may increase the lock-in characteristics of several agricultural systems. This study opens out from field and farm scale to the whole food system, without ignoring the fact that farmers are key actors in designing cropping systems that include legumes.

4.1. Sustainability Outreach of the Legume Supply Markets

This investigation shows that the supply market for different legume companies, which is situated in very diverse agricultural settings, as shown in Table 2, is changing fast, and is influenced by customers wanting new products and product combinations in their diets. It also reveals that new and existing players, both large and small companies, are entering the legume market with novel products and further indications that various new and existing small, medium, and large companies within the legume business will enter the supply market in the next few years. Cargill, for example, has recently made a large-scale investment in using pea as a supplement to its current soybean business [55]. A newer medium-sized Danish company, Naturli' Foods, which manufactures plant-based products such as plant beverages, minced plant "meat", and, more recently, plant-based food ingredients for the food industry, is now marketing its legume products on the US market. It experienced 700% growth within just a few years, and hence is not intimidated by geographical distances. The Norwegian "The World Is My Oyster" company fits into the above paradigm, importing typically conventionally produced feedstock requiring the "unnecessary use of chemicals and other technologies . . . " [33] (p. 8) with additional long transportation distances to sell it. This involves the double transport of Danish yellow pea for grinding and air separation and then its return to Denmark for extrusion to meet demand from global markets. Cultivating more legumes in Europe would allow for a reduction of soybean imports, with expected environmental benefits in Europe and also overseas [56]. Furthermore, a potential reduction of livestock production, due to more plant-based diets, reduces grain feed requirements, providing suitable legume crop areas with attainable yields and relative profitability for the average farmer. Looking ahead optimistically, increasing demand for more locally/regionally/nationally grown grain legumes will change land use practices, influencing temporal and spatial crop diversification, mitigating climate change, and reducing pressure on soil and the use of pesticides and artificial fertilisers, etc. [4,8,54]. From the perspective of sustainable farming, increasing the area under legumes reduces the emission of greenhouse gases [4] while allowing for the sequestration of carbon in soils [31], and leads to a reduction in fossil energy inputs in the system, thanks to N fertiliser reduction [7,19]. Thus, the individual farmer producing grain legumes fixes the atmospheric nitrogen and produces a high-quality and high-value

protein product for a growing market, while releasing nitrogen into the soil, influencing microbial activities and enhancing soil organic matter.

However, there is a risk of extensive transportation of such grain legume products to reach global markets. Currently, only very limited changes are taking place in agricultural practices [48], sustaining the food supply system at Levels 1 and 2 (Table 3), and thus increasing the distance between growers and consumers. Real and more fundamental changes can be applied at a local or regional level, however, where producers and consumers interact [48] and "food citizenship" [21] evolves in the local area with shorter food chains and an ongoing dialogue between the various stakeholders.

4.2. Contributions to Regime Change

High-quality protein flour mixed with minced meat, for example, could have good market potential in a future food supply system with great market share opportunities embedded in it. The nature of the legume product, however, is mainly for it to be mixed with familiar food, and the extruded product removes the bitter taste of the shell, increasing the share of yellow pea in the mixture. This means, on the one hand, that the alternative yellow pea protein flour will not necessarily give many consumers a sense of environmental awareness, because it is invisible in the food mix; on the other hand, owing to this, it could potentially acquire very large shares of the global legume market. The 'levels' of food system change [21] may not exceed Level 1 with an agricultural practice that merely improves the efficiency of already-familiar and developed agricultural systems (Table 3). In contrast, mixing legume protein into well-known products does not necessarily mean reducing the quality or making the product cheaper. Already today, some of these mixed products are advertised as being "good for the environment", possibly motivating some consumer segments who have a greater awareness of food ingredients and healthy diets.

In contrast, the Danish "Local Is Beautiful" case is the exact opposite to "The World Is My Oyster" company when it comes to market share and "levels" of food system change. The estate has re-introduced the cultivation of organic chickpea in the local area and hence is contributing to a more diversified cropping system (land use), while organic lupines are cultivated with another organic crop in a newly organically certified part of the estate in response to the growing organic market. Animal manure is used to fertilise the soil and will thus "enhance the recycling of biomass, with a view to optimising organic matter decomposition and nutrient cycling over time" [33] (p. 8). This reduces the carbon footprint compared with artificial fertilisers. As a result, that the estate could be placed in Gliessman's Level 3, where fundamental changes in agricultural practices are introduced, possibly heading towards Level 4. Nevertheless, when looking at the extent to which this company's market share can influence changes towards a more sustainable food supply, its impact is limited. Chickpea and lupine are used in the estate's restaurant, and small quantities of chickpea are sold to a single Danish retailer for further distribution. For now, it is still an early stage within the farm estate's other businesses, with the co-evolution of both field and processing technologies, and business model structures.

Future plans, which revolve around stronger and expanded networks of chickpea producers and consumers, indicate that the impact of the estate's activities can increase over time. The estate's business overall is run by the ninth generation of the family, with very close communication between activities of production (husband) and consumption (wife), ensuring that decisions that are made in the small legume "incubator" business are shared, including the products offered and their targeted marketing. The estate is well known for its ability to innovate its business to develop and grow a network of small-scale farmers in the area, and upscale and sell chickpeas to the local community and/or to national retail chain(s). It is anticipated that it could potentially provide "stronger food cooperation in the local community" just as the "food chain is shortened" [21], indicating a possible transition pathway towards new food system developments (Level 5; Table 3) in Denmark, which are dominated by a long and proud tradition of global food chain exports.

4.3. Inclusive Agrifood System Actions

In the "Local Is Beautiful" case, the emphasis is not only on being part of the growing global market for legumes, but also on securing an adequate, healthier, and more sustainable local food supply system. A major part of arable production goes to a very competitive feed market with a typically low profit. That is part of the motivation behind using the increasingly environmental values of food promotions [4] in its business development, together with faba beans for feed in pig and turkey production to replace imported soybeans. Linking together restaurant food professionals in the same business unit provides novel possibilities to attract or maintain such customers, moving towards a greater reduction in the consumption of animal calories for health benefits [57]. The estate's main activities are part of the strong lock-in effects within the dominant agrifood system, while promoting interest in a greater consumption of grain legumes. The mechanisms through which its food legume initiative can contribute to regime reconfiguration are still unclear.

The two medium-sized companies (Table 1) are seeking to expand their market shares by including flour for use as a food mix additive. The large Norwegian company is already well established on the market. This market is linked to major meat, dairy, and seafood companies seeking alternatives to animal proteins with the backing of governments worldwide [58]. Nevertheless, by "reducing external resource usage, e.g., fossil fuel energy, for transportation purposes [33] (p. 8), the Portuguese business model complies with a Level 4 transition (Table 3), with the main supply to national markets of chickpeas grown in the local area. The German company collects faba beans from a larger geographical area in Europe and then exports them globally, with far less emphasis on re-establishing a more direct connection between those who grow food and those who consume it. The plant protein substitution of animal protein on a 1:1 basis simplifies the sustainable food system transition that is very much connected to territorial level contextualisation [22–24]. The giant industries behind solutions for more plant-based diets may, in the end, cause increasing dependence on fossil fuel energy and promote standardised (westernised) diets of processed foods, reinforcing supply chains that harm people and the planet [58].

4.4. Ability to Disrupt Dominant Businesses

Value chain expansion can happen when new equipment is purchased in order to be able to apply the legume flour processing steps inside (Norway & Portugal) or outside the core business by external milling companies (Germany), including suppliers of milling equipment. However, a tendency has been identified of coupling the legume products (flour) to conventional food products, both nationally and globally, to increase market shares. Alternative meat sales currently represent 1% of the world market for meat, but this could grow to 10% by 2030, encouraging major processing companies to exploit these profit opportunities with acquisitions to maintain future markets [58].

The Danish case is different because it focuses on increasing the local legume value chains by linking various farmers' cultivation of legumes, and hence developing and strengthening local collaboration to create a hub for selling and marketing the legumes in the restaurant and farm shop—and possibly retail chains, as well. It is driven by a greater emphasis towards strengthening the economic viability of rural areas based on short marketing chains, and both fair and safe food production [59]. The focus is thus not on further processing of legumes or expansion of the value chain with traders, but mainly on gaining market share and developing local value chains with high-quality niche products. It is linked to the integration of food legumes in local crop rotations in typical cereal-rich rotation schemes as important ingredients to promote more sustainable agriculture [8,54]. This is especially true for Denmark and Germany (Table 3). This modified system can deliver several important services to society [54,60], shifting the intensification paradigm towards diversification strategies in Europe with support from increasingly green public procurement, as anticipated by all four company case studies.

4.5. Rare Farm and Fork Presence of Grain Legumes

Based on the empirical data, the authors are confident that larger volumes of legumes will soon be cultivated in Europe, with more being targeted for human consumption. That said, the case study investigations underline that movement of this kind is challenging. A development of "innovation niches" outside of the dominant sociotechnical regime is challenging, and relevant policies influencing planning initiatives from the EU and national governments are required in order to combat lock-ins from the dominant system [48,58].

The "Local Is Beautiful" case provides a paradigm shift in ways of cultivating and marketing traditional products, whereas the other companies are seeking (more or less) to enter traditional food supply markets (regime), investing in processing to increase the bulk (volume) of their modified production, increasing their competitiveness on price, and thereby their market shares. Taking into account the experimental status of the paradigm introduced on the Danish estate, and given the major business is continuing under regime rules and values, all four companies included in the present study reflect the historical interconnected transition of agriculture and food systems. Indications of new market demands are attracting attention, with relevant businesses offering opportunities for grain legumes, but there is limited facilitation of dual transitions along the whole production–consumption value chain. There is a need for guidance if the multiple actors involved are all to go in the same direction [4].

5. Conclusions

The investigation of four company case studies in Europe focusing on the supply market for grain legumes provides novel knowledge about how processing companies plan to increase their market shares and how they will adapt and operate on the legume market in future. Although some may view four cases as a limitation impeding generalizability, such investigations within real-life contexts are shown to provide rich information with which to qualify our researcher explanations. Existing large players (such is the case with "The World Is My Oyster") are acting fast to satisfy new food supply market demands, followed by start-ups (such as "Bigger Is Better") applying strategies for product expansion. Others (as in the "Southern Comfort" case study) seek to continue their business activities with an emphasis primarily on local and national markets, followed by others' strategic activities ("Local Is Beautiful", for example) within the overall business model to explore new opportunities. The contribution to sustainability associated with these strategies is rather limited, however, implying small system changes. Thus, substantial changes are a long way from happening in European grain legume supply markets, although legume cultivation for human food will increase in the future and become an increasing part of the existing food supply system (regime). Even though small niche-level developments are emerging, these might not provide the level of disruption required to shift dominant companies and food consumers in the current regime towards more leguminous protein pathways in future.

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