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Sustainable legume-based foods: from collaborative diagnosis to co-creative concepts

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ABSTRACT: Legumes offer valuable agricultural and nutritional properties to face the urgent need for food system changes. To eco-design legume-based products, the value chains need to consider the constraints of their stakeholders, from farmers to consumers. This article describes an eco-innovation approach combining collaborative value mapping with KCP® workshops to design sustainable legume-based foods. This eco-innovation approach led to the emergence of expected concepts linked to the properties of products and more disruptive concepts related to dynamics in the value chain. Existing knowledge and knowledge gaps were identified. The results highlight the value of articulating value mapping and KCP® workshops. The approach proved to foster innovative, systemic solutions that consider both stakeholders' needs and sustainability.

KEYWORDS: collaborative design, innovation, ecodesign, value mapping, KCP® workshops

1. Introduction

To face the urgent changes needed in human production activities and consumption (IPCC, 2023), far-reaching transitions in food systems are crucial, with production practices evolving towards greater sustainability and consumption shifting towards a more plant-based diet.

Legumes have been proven to have interesting agronomic properties, as several studies have shown that they have nitrogen-fixing properties in soils, causing a decrease in the use of fertilizers (Schneider & Huyghe, 2015). Furthermore, they have a high content of proteins, fibers, vitamins, and minerals (Curran, 2012), which makes them ideally placed to meet nutritional needs.

Despite these seemingly positive aspects, several studies have demonstrated that the legume value chain encounters several issues. From a consumer perspective, the acceptability of legume-based food products in Western communities tends to be low due to the presence of beany and grassy flavors (Ben-Harb et al., 2022) or bitterness and astringency perception, digestibility issues (Kumar et al., 2022) and cooking difficulties (Melendrez-Ruiz et al., 2019). From a producer perspective, the production of legume-based proteins tends to be less economically attractive and market-competitive than animal proteins due to less favorable conditions for farmers (Varela-Ortega et al., 2022). In addition, the quantity of legume-based products is exploding on the market, but the sustainability benefits of these products have not been proven (Huguet et al., 2023).

Therefore, to ensure sustainability in product design, it is essential to adopt a more comprehensive approach that integrates the critical criteria of all the legume value chain stakeholders (farmers, seed producers, primary and secondary manufacturers, distributors, and consumers). The legume value chain needs to organize itself from farmers to consumers to reconnect and consider the needs and constraints of the various stakeholders and to eco-design legume-based products. Indeed, design processes too often remain segmented between the various stakeholders in the value chain and are often aimed at adapting to the specifications of downstream stakeholders (such as processors, distributors, and consumers) from a

perspective limited to silo-based reasoning that is not conducive to adequate collaboration (Meynard et al., 2017). Furthermore, sustainability issues are not always included in these design processes.
To address these challenges, methods such as the Eco-Ideation Stimulation Mechanisms (Tyl et al., 2017) have emerged, which recommend using a form of environmental diagnosis to support creativity. However, this approach does not necessarily allow designers to explore disruptive concepts beyond fixation patterns. The article aims to propose an approach that facilitates this articulation based on the "innovation by stakeholders" mesomechanism (Tyl et al., 2017). The approach starts with value mapping (Bocken et al., 2013) and combines it with the KCP® method (Hatchuel et al., 2009), an ideation method designed to help explorations beyond fixation zones. This work focuses on eco-designing sustainable legume-based foods as a case study.

2. Research method

2.1. Stakeholder-driven eco-innovation

Tyl et al. (2017) describe the following steps for stakeholder-driven eco-innovation: (1) identify the stakeholders being part of the system, (2) identify significant parameters, and (3) generate concepts. This work is part of a collaborative project aiming to contribute to food transition by designing innovative legume-based ingredients and products. The project brings together a wide range of stakeholders: academics for the scientific research part, as well as representatives of the production chain (seed companies, primary and secondary processors, and ferment producers), who represent some of the various stakeholders in the system.
Determining the significant parameters involves understanding what each stakeholder expects from the design system. Value mapping was used to determine the values created and destroyed and the new opportunities offered by the project (Bocken et al., 2013) (Figure 1). The generation of the concepts was not conducted directly from significant parameters (in particular, destroyed values and new opportunities) because this approach can lead to a lack of originality in the ideation phase. These significant parameters were translated into concepts that enable stakeholders to break out of their habitual thought patterns during innovative design workshops using the KCP method (Hatchuel et al., 2009) (Figure 1).

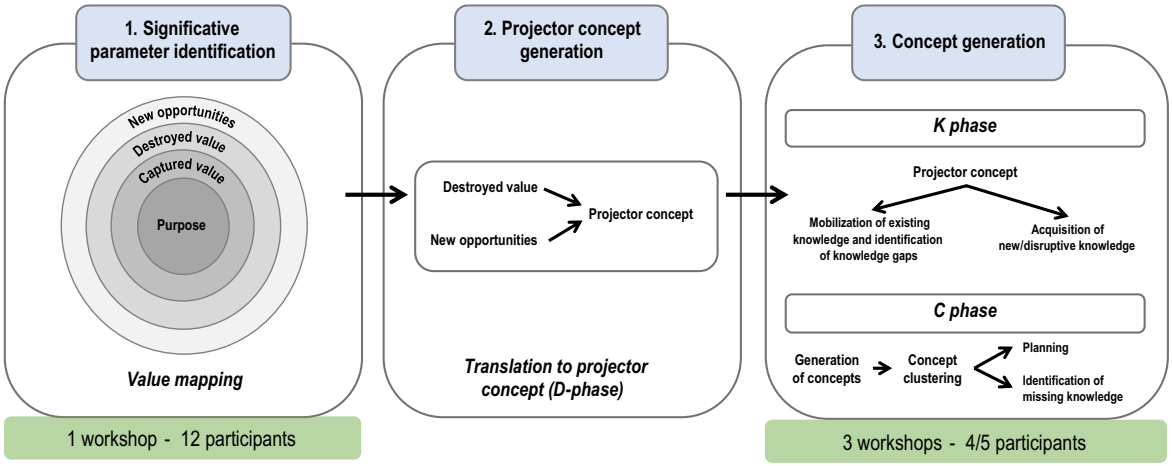

Figure 1. Overview of the used research method

2.2. Value mapping

Theoretical background

Value mapping is a tool developed to help design more sustainable business models by linking and collaborating with multiple stakeholders integrated into this model (Bocken et al., 2013). Within a multi-stakeholder project, value mapping helps to (i) analyze the positive and negative aspects of new product development (NPD), (ii) determine the points of consensus or dissensus between diverse stakeholders, (iii) identify barriers and opportunities for advancing toward a more sustainable model. It differs from other eco-design tools in that it encourages thinking beyond the stakeholder system of a value chain by integrating invisible stakeholders, such as society or the environment, to foster innovation and bring

people to think about the sustainability characteristics of the business model. Value mapping provides a comprehensive framework for driving sustainable innovation (Bocken et al., 2013):

- ***Captured values***: benefits brought to stakeholders or created by stakeholders,
- ***Destroyed values***: negative impacts brought to stakeholders or created by stakeholders,
- ***New opportunities***: benefits arising from project completion.

The value mapping workshop had three main objectives. First, it aimed to understand what each stakeholder expects from the system, as balancing these interests is crucial for making optimal design choices. Second, participants were asked to empathize with other stakeholders to understand how they perceive each other's values, identifying potential conflicts between different expectations. Lastly, the workshop sought to identify each participant's most important values, offering insight into priorities and possible negotiation levers for design criteria. These objectives highlighted key factors like destroyed values and stakeholder relationships, which informed the concept generation process.

Value mapping workshop

The value mapping workshop lasted three hours and brought together twelve participants: six researchers, two ferment producers, one ingredient producer, one finished product producer, one consumer, and one Corporate Social Responsibility (CSR) manager from a research institute (representing the environment). The consumer and the CSR manager were external to the project and participated as guests. The presence of the CSR manager made it possible to associate the environment and society with a person whose job is to consider environmental and social sustainability issues, thus facilitating the visibility of these stakeholders. The environment is a so-called "invisible" stakeholder since it cannot express itself. Participants must thus make a real effort to embody this role. For scheduling reasons, the project's other stakeholders could not be represented.

The workshop was conducted as follows: i) First, the participants were given a definition of value and examples of types of value identified by Boly et al. (2016): *Finance* (a profit margin is generated), *strategy* (a competitive advantage is created), *knowledge* (new knowledge or know-how is generated), *consumer capture* (a consumer-producer interdependence is created), *function* (the product offers new services), *notoriety* (the product helps the company improve its reputation), *hedonism* (the stakeholders' motivation for the project is increased), *sustainability* (social, environmental, or economic impacts are reduced), *innovation* (the product is innovative), and *business* (the market share is increased). ii) Then, using empathy, the participants described two pre-defined stakeholders' values (sequentially their captured value, destroyed value, and new opportunities) on sticky notes. Participants were then divided into pairs, and each pair had to cluster the sticky notes of a specific stakeholder (different from the ones they studied during the first part of the workshop). Each pair had to present their clusters, and the participants were invited to discuss the identified values, debate, and add more sticky notes when ideas were forgotten. Emphasis was placed on the fact that the actual representative of each stakeholder had to explicitly agree or disagree with what was written in the sticky notes. iii) In the final step of the workshop, each participant received three colored stickers and placed them on the sticky notes or clusters they considered most important in the project. The discussions were recorded with the consent of the participants to allow accurate analysis.

2.3. Transforming destroyed values to generate ideas and concepts using the KCP method

The KCP method uses the C-K theory to explore the unknown to be innovative and offer a practical framework for designing innovative systems, services, or products (Hatchuel & Weil, 2003). It provides a workshop framework to generate innovative concepts, overcome bottlenecks, and get different stakeholders to think out of the box (Hatchuel et al., 2009). We followed the four steps described in the KCP method:

D phase (before a workshop)

In the theory, a diagnosis of the situation and the stakeholder system is performed, the problem at stake is defined, the field of innovation is framed, the design process is planned, and the objectives are prioritized. Projector concepts and knowledge gaps are identified. Projector concepts are used in KCP workshops to shift participants' thinking away from their usual design patterns. They are generally

defined by considering the fixation paths the collective would spontaneously explore to overcome them. This definition of the concepts to be projected is decisive for exploring disruptive concepts and knowledge.
In our case study, these steps were structured by the value mapping analysis described below. We identified three projector concepts thanks to the value mapping analysis: A "VIP" legume-based ingredient (C1), a legume-based "source of biodiversity" ingredient (C2), and a legume-based stakeholder-friendly product (C3). Three three-hour KCP workshops were conducted, one for each projector concept. Two of them reunited different stakeholders as part of the project (a representative of the final product producer and researchers specializing in different areas such as chemistry, sensory analysis, and consumer science). Five participants took part in each of these workshops. The last workshop exclusively gathered four researchers.

K phase (during a workshop)

In the theory, existing knowledge is pooled, knowledge gaps are identified, and disruptive knowledge is brought to the participants.
In our case study, different experts who could bring disruptive knowledge during the K-phase (which lasted 15 minutes) of the workshops were recruited and asked to prepare a presentation of the state-of-the-art and the non-art regarding these concepts. The author gave information about the concept of "VIP", a researcher in agricultural engineering discussed the link between legumes and biodiversity, and a researcher in agronomy addressed the current locks in the legume value chain. The participants were encouraged to share their insights and ask the experts questions.

C phase (during a workshop)

In the theory, new concepts that deviate from the participants' fixation areas are explored through ideation. In our case study, the participants generated new concepts around the projector concepts individually on sticky notes. This phase lasted around 20 minutes. Participants were given a mood board displaying pictures corresponding to the projector concept to stimulate their creativity. Each participant then presented their concepts to the others: existing knowledge and knowledge gaps were identified, and the concepts were discussed. Then, they clustered the sticky notes and named the clusters on a paper board without any guidance from the author. The final part of the workshop (45 minutes) was a presentation of the different paper boards and a collective discussion about the feasibility, relevance, and potential missing knowledge to plan a future design strategy. The discussions were recorded with the consent of the participants to allow accurate analysis.

P phase (during and after a workshop)

Existing and missing knowledge is organized, and the participants select the most interesting or feasible concepts. The aim is then to identify actions to conduct the future design strategy. Due to time constraints, this step could not be conducted in our case study.

3. Findings

3.1. Value mapping

3.1.1. Overall results

The participants understood the principles of value mapping and empathy work and seemed to understand the expectations of the other stakeholders well. A total of 244 sticky notes were written for all the panels. Each panel describes the values associated with a stakeholder. It seems to have been easier for participants to imagine values created by the project (104 sticky notes) than new opportunities (74 sticky notes) and destroyed values (66 sticky notes). The number of sticky notes per panel is: environment (41), consumers (31), farmer (31), finished product producer (29), seed producer (20), research (19), ingredient producer (19), ferment producer (18), distributor (16), society (11), funder (9). However, these results must be qualified, as the number of participants assigned to each panel differed for all panels. Three participants focused on the environment, whereas two studied the other stakeholders. Participants wrote several sticky notes (with a mean number of 20 sticky notes per participant), whatever the stakeholder or type of value concerned. During the feedback and discussion phase, the values created, destroyed, and new opportunities were clear to the consortium, which agreed with the sticky notes

generated by its fellow workshop participants. The participants represented by the panels were broadly in line with the vision of their expectations presented by the other people, agreeing with what they said. However, some participants found it more difficult to put themselves in the shoes of specific stakeholders, primarily more conceptual or "invisible" stakeholders such as society or the project's funder. At the start of the first phase, for example, some participants said, "*It is hard to know what is being created for them when you have never met them*," referring to funders or society.
In addition, eleven sticky notes were added during the paired feedback phases for the seven panels concerned, with five of them generated by participants who represented the stakeholder, showing that empathy was not entirely sufficient to identify their vision.
Some stakeholders, such as farmers, distributors, and the government, were absent from the workshop. Without an explanation of their vision of things and a "verification" of the values evoked by those who put themselves in their place, it becomes difficult to determine whether the empathy work was mobilized authentically for these stakeholders.

3.1.2. The common thread running through the project is the triangle between consumers, products, and corporate image

The sticky notes and colored sticker placement analysis suggest that stakeholders prioritize the link between the designed products and consumers. Indeed, 9 of the 33 colored stickers were placed on consumer panel values, and 8 of the 11 participants placed at least one of their stickers on consumer panel values. The two aspects that stood out most were consumers' acceptance of finished products and the beneficial effects of these products on their health. A strong link with finished products can be identified: 7 out of 33 stickers concerned the producers of finished products. The majority of these regarded the sensory and physicochemical innovation of finished products (4 out of 7), followed by the potential health benefits of these products for consumers (2 out of 7).
The link between products and consumers is critical for the finished product producers as it directly governs the company's image and future innovation opportunities. The discussion phase on this panel enabled the company representative to elaborate on the economic and symbolic interests or risks that had not been identified by the other participants and which nevertheless seemed crucial. During the final phase, this participant even put a sticker on the new opportunities described as *"develop the company."*

3.1.3. Environmental sustainability is relegated to farmers

A striking aspect of this workshop is that environmental sustainability seems to be considered mainly in the agricultural phases of the legume value chain. The environment could be seen in two ways: as a stakeholder, with sticky notes on the corresponding panel, and as a value linked to another stakeholder. Sticky notes linked to the environment were thus expected on all panels.
The values destroyed regarding the stakeholder "*environment*" were generally not directly concerned with environmental sustainability and the project's harmful impacts on the planet but with other associated aspects such as legume consumption (for instance: "*Is a plant-based diet adapted to everyone's needs*?") and the economy. Even during the discussion phases, it was challenging for the manufacturers to imagine that their processing methods could be resource-intensive, polluting, or even sub-optimal, *"I do not see how the project can harm the environment."* Moreover, for the panel concerning the producers of finished products, only one sticky note out of 29 referred to environmental sustainability. These results suggest that the stakeholders present at the workshop found it difficult to put themselves in the shoes of this "invisible" stakeholder. Even during the participants' feedback phases, the subject did not come up for this stakeholder.
Contrariwise, in the discussions and the analysis of the sticky notes, a phenomenon of delegation of environmental sustainability issues from manufacturers to farmers emerged. Indeed, most colored stickers placed by the manufacturers on sustainability issues concerned farmers and the decisive role they could play in limiting the value chain's impact on the planet: "*produce better, more sustainably"* (4 stickers) or "*limit and/or eliminate chemicals from my production for everyone's health*" (1 sticker). The other colored stickers prioritizing environmental sustainability aimed at much broader concepts, such as "*optimization of resources*", *"biodiversity"*, or *"sustainability"* on the environmental panel.

3.1.4. The collaborative project creates value and new opportunities

One value that emerged most strongly in the interactions between participants (i.e., more in the discussions than in the generation of sticky notes) was the novelty of collaborative projects. Indeed, in the

discussions, it emerged that manufacturers, and food processors in particular, were not used to being gathered in this way and to being part of projects concerning an entire value chain.
This notion was reflected in the discussion phase by adding two sticky notes, *"Developing collaborations and agility for multi-partner projects"* for the finished product producers and *"Developing partnerships"* for the ingredient producers, in the category of new opportunities.
Even if the producers had not yet necessarily thought of bringing this idea to the fore in the first phase of the workshop, interactions with other stakeholder representatives brought out their shared interest in setting up collaborations. They felt it was essential to initiate new projects involving more stakeholders from the relevant sectors to be aware of each other's needs and constraints while at the same time being able to put forward their respective interests. Therefore, one can imagine that these stakeholders are not used to working collaboratively but that this project acts as an "initiation" for future projects.

3.2. Projector concept generation

The core of this work lies in translating the destroyed values and new opportunities identified during the value mapping workshop into projector concepts to be used during KCP design workshops to bridge the gap between the diagnosis and design phases. The three most essential points identified through value mapping led to the emergence of the following projector concepts in a pre-workshop analysis:

- ***C1: a "VIP" legume-based ingredient.*** We worked around destroyed values such as "*Lower value added for new source material*" and "*loss of consumer orientation*". In food product design, much attention is focused on the finished product, and to shift this point of view, we are looking here to valorize the ingredients. Our inspiration was computer processors, often highlighted by a label on the device. The project's common thread is the link between the image of processors, products, and consumers, so the term "VIP" was chosen to combine all three.
- ***C2: a legume-based "source of biodiversity" ingredient.*** The destroyed value considered was "*polluting production*". Biodiversity is not an obvious entry point for food processors, who focus more on energy and water savings. The idea was to get them to think about a life-cycle approach and how their ingredients and products could be a source of biodiversity. This concept also emphasizes the fact that taking environmental sustainability into account is relegated to farmers. The aim was to go beyond sustainability in the agricultural phases to question the value chain system.
- ***C3: a legume-based stakeholder-friendly product.*** The entry point was the destroyed value "*financial endangerment*" of the farmers. This concept is also based on the fact that the collaborative project is new for the participants. By integrating a desirable element (the "stakeholder-friendly" part), the aim is to get the various stakeholders of the value chain to collaborate more effectively during the design stage and to take better account of the needs and constraints of all stakeholders (in particular those of the farmers which are generally left behind).

3.3. KCP workshops

A total of 115 sticky notes were written during the three KCP workshops (respectively 41 for C1, 32 for C2, and 42 for C3). All sticky notes were considered for the analysis of the results. They were sorted according to two criteria: the nature of the sticky notes (concepts or knowledge) and the level of originality of the concepts (whether or not they fit into the fixation patterns). An example of the results is provided in Figure 2, related to the C3 concept.

3.3.1. C1: a "VIP" legume-based ingredient

Different ways exist to add value to an ingredient and make it a "VIP." Several identified concepts remained in the fixation patterns of the stakeholders: an ingredient can be valorized thanks to its good sensory or nutritional properties, such as "*Gourmet*", "*The magic ingredient to help our transit*", or "*A noticeable ingredient*". However, some concepts were more at odds with conventional design. A participant mentioned that an ingredient could be valorized thanks to its good environmental properties with concepts such as "*Eco-friendly leg*", "*Biodiv leg*", and "*Zero GHG leg*." Indeed, by showing that a product can be attractive because its production has a minimal impact on the environment, these concepts break away from the vision of processors, who tend to be more interested in the act of consumption. In addition, original concepts concerning the potential multi-functionality and versatility of products

emerged. For example, an ingredient could be VIP because it could be included in all types of dishes ("*Multifunctional ingredient for sweet and savory preparations*") or consumed at any time of day ("*Ingredient used from breakfast to dessert*"). To summarize, in this workshop, innovative ideas (outside the participants' fixation areas) emerged thanks to the identified projector concept. These ideas relate to original product properties such as low environmental impact and multifunctionality.

3.3.2. C2: a legume-based "source of biodiversity" ingredient

Many concepts that emerged during this workshop focused on agricultural phases, describing different aspects of biodiversity, such as soil and crop species ("*Diversification of species and crops*"). These concepts tended to remain in fixation paths that are usually explored.

However, more disruptive concepts also emerged. Firstly, biodiversity was broadened to include microbiota biodiversity. Some participants exploited the link between the microbiological properties of legumes and human digestive flora through concepts such as "*Endogenous legume biodiversity enriches human microbiota*" and "*The benefits of the flora already present in legumes*". Secondly, an interesting point was that for changes to make sense and be implemented effectively, there needed to be a paradigm shift at the level of consumers, who are among the key stakeholders in the chain. Indeed, a participant reported that implementing practice changes would be very difficult without real consumer sensibilization on legumes and their consumption, with the concept "*Education to avoid crop standardization (review our expectations as consumers)*". Areas of knowledge were also explored, including agricultural diversification, soils, and symbioses between legumes and microorganisms. The key result is that, as in the previous workshop, participants came up with disruptive ideas linked to the original properties of the product to be designed, this time a microbiota favorable to the human microbiota.

3.3.3. C3: a legume-based stakeholder-friendly product

Many sticky notes focused on consumers, suggesting that their needs and acceptability are considered predominantly in food product design. One interesting result is that respect for consumers involves inherent product properties, such as "*Taste and digestibility*", and the act and experience of consumption: "*Easy to prepare*". Therefore, design paths to achieve consumer-friendliness must consider the product's inherent characteristics and use. These concepts were not necessarily disruptive and remained in the area where stakeholders are fixed *a priori* (Figure 2).

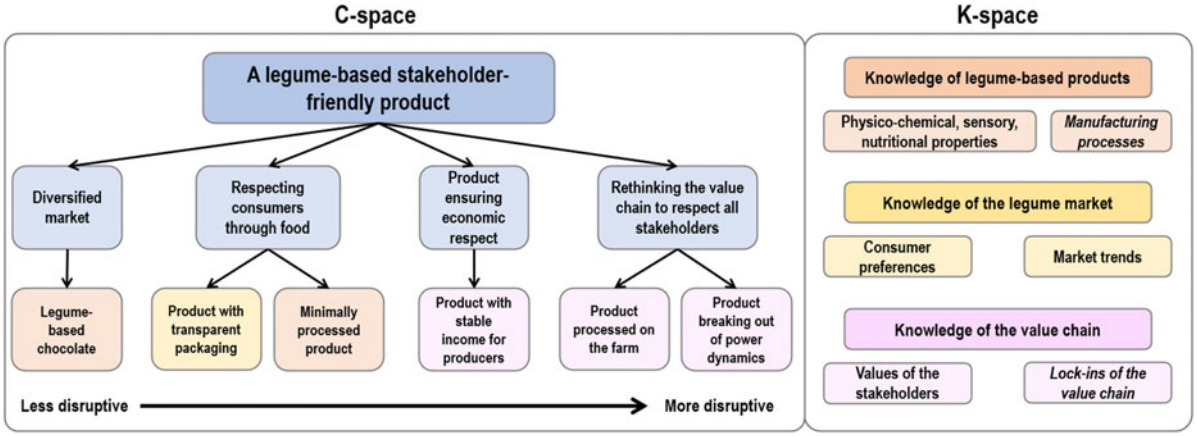

Figure 2. Example of a C-K tree for the projector concept "A legume-based stakeholder-friendly product"; Only a few concepts are listed. Knowledge gaps are in italics

However, other sticky notes concerned stakeholders other than consumers. Indeed, several ideas emerged concerning the economic remuneration of stakeholders in the chain, particularly farmers. At a macroscopic level, the cluster entitled "*Rethinking the value chain to respect all stakeholders*" asserted that respect for all stakeholders in the value chain must be achieved by reorganizing it, notably by freeing itself from the logic of power dynamics imposed by the key stakeholders (the manufacturers and the consumers). A participant also mentioned that legumes could become "*The basis for renewing the relationships between stakeholders in the value chain*".

Two different levels of originality thus emerged from this workshop: a local level for consumers and a more radical and disruptive level by recomposing the legume value chain. This dual level can also be identified in the questioning around the notion of respect in the clusters entitled "*Ease of use and food preparation*", "*Diversify the offer for different consumption moments*" and "*Rethinking the value chain to respect all stakeholders*". It is possible to respect consumers through the product by not changing their habits (the design remains in fixation patterns). However, change needs to occur more systematically to respect all the stakeholders in the value chain. To summarize, in this workshop, participants came up with original ideas related to the need for a paradigm shift among stakeholders (consumer habits, distribution of monetary value in the value chain, and respect for the needs of the various stakeholders).

4. Discussion

4.1. Implications for the design method

It is crucial to work on innovation integrating stakeholders, specifically in the legume sector (Magrini et al., 2016), as it is precisely in the systemic dynamics between the various stakeholders that many of the obstacles to the design of virtuous products emerge (Meynard et al., 2018). Articulating the value mapping and the D phase of the KCP workshops helped generate disruptive concepts relevant to the stakeholders' concerns and facing environmental challenges, thus overcoming the lack of originality that can arise from eco-ideation methods such as stakeholder-driven eco-innovation. It also allowed the participants to think beyond their position in the project and consider the points of view of other stakeholders. Indeed, one of the difficulties of the KCP method is that the D phase is not entirely formalized, which may lead to the emergence of concepts distant from the stakeholders' constraints, usages, and their "tangible work situations", especially in agriculture (Cerf et al., 2012, p10). In addition, this work proposes to use destroyed values to generate projector concepts for innovation design workshops, which led to the exploration of disruptive concepts. These destroyed values are reoccurring in sustainable business models but are rarely used as a lever for innovation (Osmanovic et al., 2024). This study highlights the value of articulating value mapping and KCP workshops and the importance of broad stakeholder representation and extended timeframes in workshops to deepen empathy-driven insights, refine concepts, and advance the design process toward actionable and collaborative solutions.

4.2. Implications for the design of legume-based products

The participants of the KCP workshops considered design avenues that do not really deviate from classic design schemes by improving the inherent properties of products. These properties generally revolve around consumers and the act of consumption and constitute technical-economic criteria that are generally well taken into account when compared to environmental criteria (Perrin et al., 2023). Nevertheless, while traditional product concepts were mentioned ("*Legume soup*), "crazy concepts" such as "*Multi-purpose ingredients used in savory and sweet foods and at every meal*" also emerged. Sweet legume-based products are, in fact, under-represented, the products most present in France in recent years being plant-based meat alternatives, followed by plant-based drinks (France AgriMer, 2024). Therefore, legume-based products could be more surprising and diversified by considering uncommon uses or times of consumption. Health issues that remained in the fixation areas of the stakeholders also emerged. The nutritional benefits of legume fermentation, which could also produce new aromas by exogenous microorganisms, were discussed. For instance, the bioavailability of nutrients in fava beans through the use of lactic acid bacteria can be improved (Verni et al., 2019). More complementary efforts could be focused on studying the endogenous flora of legumes and its potential benefits to make the most of them. In addition, minimal processing was mentioned as a desired property for legume-based products in opposition to ultra-processed foods to reduce health risks. While studies have shown a correlation between ultra-processing and weight gain (Hall et al., 2019), the causal links between consumption of this type of food and negative health impacts still need to be established. In other words, the concepts mentioned above are product improvements or redesigns that view the environment as a constraint that must be considered (Brezet, 1997).

However, each KCP workshop enabled the stakeholders to explore beyond these fixation patterns, especially concerning the dynamics in the value chain. The participants considered a broader vision of the design system, in which the environment becomes a lever for systemic innovation (Brezet, 1997) that could enable stakeholders to reorganize the entire value chain. This aspect was highlighted in all three KCP workshops to enable the design of a product that is respectful of the stakeholders of the value chain

and a source of biodiversity. Consumers have been identified as an entry point for implementing changes in dynamics ("*Re-education to avoid standardization and review our expectations as consumers*"). Their eating habits are often questioned and subjected to injunctions from public policies, with little to no effect (Mozaffarian et al., 2018). A real educational effort is needed to reconceive their expectations of legume-based products. These changes must also involve other stakeholders in the legume market, product development, and agricultural stages to be effective (Magrini et al., 2016).

4.3. Limitations

Including all the value chain stakeholders in the workshops would be valuable in further studies. Even if the whole point of this work is to put oneself in the shoes of other stakeholders through empathy, the non-representation of specific stakeholders in this case study, particularly farmers, calls into question the relevance of the identified created or destroyed values. For example, it would have been interesting to let legume farmers discuss their vision for their panel and the projector concepts of "*a legume-based source of biodiversity ingredient*" and "*a legume-based stakeholder-friendly product*". Moreover, due to time constraints, not all the panels were studied during the pairing phase of the value mapping workshop, which did not allow for a complete assessment of the relevance of the ideas evoked. The value mapping workshop would have benefitted from more participants and more time to allow for a thorough exploration of all the panels. The lack of representation of various stakeholders was also palpable in the three KCP workshops, which reunited almost exclusively researchers. Bringing together stakeholders with different roles in the legume value chain would have raised more insights in the discussions. We suggest this should be considered in further studies.

In addition, the P phase was not initiated during the KCP workshops due to the lack of time available to participants. Overall, the workshops stopped at the concept phase. The disruptive concepts would be interesting to study in greater depth in this phase, as they could offer solutions to the destroyed values identified in the diagnosis phase, particularly those concerning environmental sustainability. Their evaluation and deepening with the various stakeholders would be relevant to guide the design and adopt desirable practices. We suggest that other workshops should be conducted in this regard.

5. Conclusion

This work demonstrates the relevance of articulating a collaborative diagnosis of the design system with the concept generation phase. Translating destroyed values and new opportunities identified in the value mapping workshop into projector concepts used in KCP workshops enabled participants to explore disruptive concepts while considering value chain stakeholders' specific needs and constraints. Participants could also draw on existing or missing knowledge to explore design avenues they had not thought of spontaneously.

It would be interesting, however, to take the process a step further by continuing to phase P of the KCP method. It could also be applied to other case studies in different design fields to confirm its relevance.

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