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Fostering legume purchases with behavioural interventions: evidence from field experiments in online and offline supermarkets

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ABSTRACT

The protein transition is a crucial element of the transition to sustainable food systems, and both EU and national policies aim to foster the consumption of plant-based proteins. Supermarkets as the primary source of food products in many countries represent a promising environment for translating these policy objectives into practice. With three studies from Denmark, including a representative online survey (n = 838 participants) followed by randomised controlled trials in a real online supermarket in two rounds over 6 weeks (n = 9,093 transactions Round 1; n = 8,706 transactions Round 2) and field experiments in physical brick-and-mortar stores (9 test stores, 13 control stores, 21 days of observation), this research investigates the potential of leveraging behavioural interventions to foster legume purchases in online and offline retail settings. The randomised controlled trials in the online supermarket showed that placement interventions in the vegetable section were effective in increasing sales of legumes by 57%, while placement interventions in the meat section were not effective, suggesting that the strategies known to work for highly processed plant-based meat substitutes cannot be translated to legumes. The field experiments in brick-and-mortar supermarkets confirmed that the vegetable section is a promising intervention point. The multi-layered intervention tested (bundling placement combined with a recipe inspiration poster) significantly increased legume purchases to a similar degree as in the other study.

This paper concludes that retailers play a pivotal role in the protein transition; however, their commercial interests may impede the implementation of ambitious in-store interventions promoting legumes, highlighting the need for innovative policy approaches.

1. Introduction

Food production and consumption are major drivers of greenhouse gas emissions, biodiversity loss, and water resource depletion (Willett et al., 2019), making transitioning to more sustainable food choices an impactful approach to mitigating individuals' contributions to climate change and other sustainability-related challenges (Zurek et al., 2022). Fostering more sustainable food choices is challenging, however, since consumers' food shopping and consumption behaviours tend to be highly habitual and deeply rooted in tradition and culture (Machín et al., 2020). This challenge becomes particularly evident when fostering a shift toward more sustainable protein sources, i.e., replacing animal-based proteins with plant-based alternatives (Willett et al., 2019). The term plant-based protein foods covers a broad range of products, including highly processed products that mimic meat; semi-processed products such as tofu, tempeh and seitan; and low-processed legumes such as dried or canned lentils, chickpeas, and beans (hereafter referred to as "legumes").

The urgent need for a sustainable dietary shift has increasingly been recognised in national and EU policies, particularly by encouraging greater consumption of plant-based proteins. At the European level, the Farm to Fork Strategy (European Commission, 2020) sets out the overarching aim of transitioning to a fair, healthy and environmentally friendly food system, and supports a dietary change away from high intakes of red and processed meat and toward more plant-based foods. Moreover, several European countries have developed national policies to support the availability, innovation and consumption of plant-based proteins, with a particular emphasis on legumes. Examples include Germany's Protein Crop Strategy (Federal Ministry of Food and Agriculture, 2020) and Denmark's Strategy for Green Proteins (Danish

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Ministry of Food, Agriculture and Fisheries, 2023). For many political initiatives, the planetary health diet developed by the EAT-Lancet commission (Willet et al., 2019) serves as a guiding framework for nutrition policy. It defines a diet that promotes human health while operating within the planetary boundaries and recommends that proteins should primarily be obtained from legumes and nuts. Accordingly, the environmental and health benefits of legumes are reflected in official dietary guidelines of several EU-countries (e.g., DGE, 2025; Danish Veterinary and Food Administration, 2025).

However, despite increasing policy support, many European countries are faced with a significant gap between recommended and actual consumption levels (Torheim & Fadnes, 2024). In Denmark, for example, the average daily intake of legumes amounts to 2-5 g, compared to 100 g recommended by the official Danish dietary guidelines (Danish Ministry of Food, Agriculture and Fisheries., 2023) or 77 g recommended by the planetary health diet (Willet et al., 2019).

Supermarkets are the primary source of food in many countries due to large product assortments, long opening hours, and high store density (Machín et al., 2020). As such, retailers' decisions on how to design choice environments strongly influence consumers' purchasing behaviour (Carroll & Samek, 2018; Thaler and Sunstein, 2008) and manifest current patterns of unsustainable food consumption (SAPEA, 2023). At the same time, changing the choice architecture in supermarkets is potentially a way to increase legume sales and support policy strategies. This is especially true because changes to the choice architecture are perceived as less intrusive and, therefore, are more widely supported by consumers than more coercive measures such as taxes or bans (Ammann et al., 2025). However, from a retailers' perspective legumes compete with other product categories for limited shelf space and promotional display space. The question is thus how to incentivize retailers to promote sustainable foods such as legumes and thus, support national and EU-policy initiatives.

A few examples of regulatory instruments influencing the retail environment to align consumer behaviour with sustainability or health policy objectives exist. One example from the UK is the Food Promotion and Placement Regulation (SI 2021 No. 1368) introduced in 2021 as part of the public health policy strategy. Based on scientific evidence highlighting the negative consequences of unhealthy dietary choices, the regulation restricts the promotion and specified in-store placement of unhealthy food in large supermarkets (Department of Health & Social Care, 2023). Another example from Denmark is the public-private partnership established to increase the intake of wholegrain. The Danish "Whole Grain Partnership" is a multi-stakeholder initiative founded in 2008 by representatives from the food industry, health NGOs, and public authorities (Fuldkornpartnerskabet, 2021). Members of the initiative quickly began implementing a wide range of in-store measures to promote wholegrain consumption (Schulze et al., 2024). Comparable instruments that incentivize retailers to actively support national and EU policy protein transition strategies are currently underdeveloped but might be a promising tool.

That raises the question of whether and how placement and promotion interventions in supermarket settings can foster legume purchases and help overcoming the gap between recommended and actual consumption levels. Various approaches to altering the choice architecture to foster sustainable behavioural changes have been investigated in the scientific literature on food consumption, mostly with lab- or survey-based experiments, while evidence from field experiments in real supermarkets is scarce (SAPEA, 2023). Most studies examining the effects of behavioural interventions in real grocery stores focused on the promotion of healthier choices (e.g., Bauer et al. 2022; Vogel et al. 2023). Supermarket field experiments focusing on environmental sustainability are a relatively new phenomenon in the scientific literature (e.g., van der Vliet et al., 2024, Wolfswinkel et al., 2025). Altogether, the studies show mixed results regarding the effectiveness of behavioural interventions on promoting healthy and sustainable food choices in real-life purchasing environments.

This research aims to close the gap by investigating the potential of leveraging interventions to increase consumer purchases of legumes in real-life supermarkets, including field experiments in online and offline retail settings in Denmark. The study draws on randomised controlled trials in a real online supermarket in two rounds over six weeks (n = 9,093 transactions Round 1; n = 8,706 transactions Round 2), field experiments in physical brick-and-mortar supermarkets (9 test stores, 13 control stores, 21 days of observation), and a preceding representative online survey (n = 838 participants). Denmark was considered an appropriate country of investigation for this matter, since animal-based protein sources, in particular pork meat and dairy, are a fundamental part of the Danish diet (Hielkema and Lund, 2021) and legume consumption levels are very low.

The results of this research contribute to the scientific discourse on the influence of choice architecture and behavioural interventions in transitioning to more sustainable food choices as well as the role of supermarkets in supporting the transition to a sustainable food system. The paper concludes with recommendations on how the retail environment can help close the gap between recommended and actual consumption levels and the importance of policy guidance to leverage the potential of the supermarket environment.

2. Theoretical embedding

2.1. Determinants of legume consumption and behavioural intervention design

Previous studies have started to investigate barriers that cause the gap between actual and recommended consumption levels of legumes. Consumers do not clearly perceive legumes as an alternative source of protein (van der Meer et al. 2023) and lack the cooking skills to prepare meals with legumes (Henn et al., 2022), to mention just a few capability-related barriers. More importantly, food choices are not solely driven by knowledge or functional considerations but are strongly shaped by hedonic factors, particularly taste and anticipated pleasure (Furst et al., 1996). Taste is consistently identified as a primary driver of food choice, in particular meat consumption (Font-i-Furnols & Guerrero, 2025), and may outweigh health and sustainability considerations, especially in the domain of protein consumption. Meat consumption also carries cultural and symbolic meaning, and has been linked to notions of tradition, status, and identity (e.g., Leroy & Praet, 2015), which may further reinforce its central role in shopping behaviour and make substitution toward plant-based alternatives more challenging.

Legumes and other plant-based protein sources are often perceived as less familiar than meat-based options (Graça et al., 2019). In addition, meat consumption also carries cultural and symbolic meaning, and has been linked to notions of tradition and identity (e.g., Leroy & Praet, 2015), which may further reinforce its central role in shopping behaviour and make substitution toward plant-based alternatives more challenging. Despite the increasing product differentiation on the market, with a wider range of products containing legumes in varying degrees of processing (Zühlsdorf, 2024) these aspects might contribute to the low consumption levels of legumes.

Like many behavioural interventions seeking to foster sustainable behaviour change, the interventions implemented in this research are theoretically based on the dual-system framework developed by Kahneman (2013). Individuals have two distinct psychological systems to process information. System 1 is associated with automatic thinking. It is fast, unconscious and effortlessly which makes it useful for everyday decisions and routines. System 2, by contrast, is associated with deliberate thinking and requires more cognitive resources for conscious reasoning and effortful thinking which makes it helpful for complex decision-making as well as unfamiliar situations (Stanovich & West, 2000). Since grocery shopping is very repetitive and guided by habit, consumers are most likely making many food choices in the food retail environment semi-automatically, without a great deal of deliberate

thinking.

The approach of organising the context in which individuals make decisions, e.g., in grocery stores, without altering economic incentives, is well-known under the umbrella term 'choice architecture' in behavioural economics (Thaler, Sunstein & Balz, 2014). Decision-making processes dominated by system 1 are often strongly influenced by the choice architecture (Hansen & Jespersen, 2013). Subtle changes in the choice architecture are a prominent example of nudging (Kahnemann, 2013).

Leveraging insights from the field of behavioural science, behaviour change models help identify potential ways of developing choice architecture interventions. The COM-B Model is a prominent example and enables the design of theoretically embedded behavioural interventions (Michie et al., 2011). By changing one or more of the three dimensions - capability, motivation and opportunity –- behavioural change can be initiated. Capability is defined as the individual's ability to perform the behaviour and includes both the psychological and physiological capabilities. Opportunity refers to external factors that enable or hinder the behaviour of interest and incorporates both the physical (e.g., resource availability) as well as social (e.g., social norms) opportunity. Motivation captures the internal processes that drive the behaviour including both the reflective (e.g., planned) and automatic (e.g., emotional, habit) dimension of motivation. The COM-B model offers a framework for developing interventions that help to overcome key barriers of sustainable food consumption (Schulze & Janssen, 2024; Stone et al., 2025).

Importantly, the present research does not directly target hedonic drivers of protein consumption. Instead, it focuses on interventions that modify the choice environment and thereby influence behaviour through changes in capability and opportunity, specifically by increasing the visibility and accessibility of legumes in supermarket settings. By doing so, the interventions operate largely independently of consumers' automatic motivation related to hedonic preferences. This research investigates whether addressing these barriers through supermarket interventions might be a promising starting point to foster sustainable behaviour change. We draw on the literature on choice architecture and behavioural interventions in retail settings, and theoretically ground the design of supermarket interventions in the behaviour change model COM-B.

2.2. Retailer decision-making and choice architecture interventions

Retailers play a central role in fostering sustainable consumption choices (Holtrop et al., 2025). However, assortments are typically managed according to category management principles that aim to maximise overall category profitability and store performance rather than the sales of individual products. From a retailer's perspective, product categories differ in their strategic importance depending on their ability to drive store traffic or increase the likelihood of category purchases among consumers already in the store (Dhar et al., 2001). Fresh food categories, including meat, are purchased frequently. They often serve as a primary reason for a shopping trip (HDE, 2025) and are thus considered an important traffic driver. Legumes, in contrast, may receive less strategic attention from food retailers.

These strategic considerations are closely linked to the physical layout of many supermarkets. In a typical Danish store, the fruit and vegetable section is located near the entrance, meat is often placed prominently in open refrigerated display cases. Other fresh categories, such as dairy, are typically located along the outer edges of the store, while shelf-stable packaged goods, such as legumes, are located in aisle shelves. As a result, consumers who visit the store primarily for fresh items (e.g., meat) or a few specific products may be less exposed to products located in the aisles (e.g., legumes).

However, important differences exist between physical and online grocery settings. In brick-and-mortar stores, consumers encounter products as they move through the store and can directly perceive items of interest. In contrast, online shopping replaces spatial and experiential navigation with search-based and interface-driven product discovery. Consequently, they can directly perceive items they are interested in. Rather than the spatial and experiential navigation that shapes product discovery in physical stores, online shopping, in contrast, does not allow physical examination of products (Chu et al., 2010). These differences suggest that interventions designed to increase the visibility of products such as legumes may operate differently across online and offline retail channels.

The interventions studied in this research target legume purchases. We acknowledge that their implementation depends on retailers' strategic priorities. Under conventional category management principles, shelf space and promotional activities are typically allocated to maximise category profitability and overall store performance, which may limit incentives to prioritise products such as legumes that are not primary traffic drivers. However, retailers are increasingly engaging with sustainability agendas and responding to growing policy and societal pressure to support more sustainable consumption patterns. In this context, some retailers have begun to explicitly promote plant-based products, including legumes, as part of broader sustainability strategies. An example is Lidl Denmark's involvement in the "legume partnership" (Bælgfrugtspartnerskabet, n.d.).

3. Study 1

The aim of this study was to examine consumers' perception of plant-based protein sources to understand their (lack of) motivation as well as capabilities and opportunities to make more sustainable food choices. The results of the representative online survey served as a basis for developing the interventions in the subsequent field experiments with (online) supermarkets. The aim of this step was to gain a better understanding of the barriers related to the consumption of legumes in a Danish context.

3.1. Methodological approach – Study 1

An online survey with Danish consumers was conducted in summer 2022. Data was collected through an online access panel provider (Norstadt A/S, Copenhagen, Denmark). Quotas for gender, age, education, and place of residence were set to represent the overall Danish population regarding those characteristics. Two quality checks were included to ensure high data quality (e.g., Please select 'totally agree' to verify that you are not a robot). Participants who incorrectly answered those questions (n = 193) were excluded from the data set. Additionally, 30 participants who took more than 120 min to complete the survey were excluded from the final dataset. The final dataset comprises n = 838 participants.

The questionnaire consisted of several parts. Next to socio-demographic information, consumers' willingness-to-eat meals with meat, meals with less meat, meals without meat but with legumes/vegetables/meat substitutes, rated on a 7-point Likert scale ranging from 1 = not willing at all to 7 = very willing to consume were measured. Additionally, consumers' perception of the different types of meals without meat were measured using a 7-point multi-item semantic differential scale (e.g., easy to prepare / difficult to prepare, tastes good / tastes bad) (see Fig. 1). Items were inspired by Tan et al. (2016) and further developed in several discussion rounds with food researchers and stakeholders working with the plant-based sector in Denmark. The questionnaire continued with a section on the Self-Determination Theory which was the basis for a previous publication by the authors of this study (Schulze & Janssen, 2024).

3.2. Results – Study 1

The sample reflects the Danish population in terms of gender, age, place of residence, and education. The sample also corresponds well to

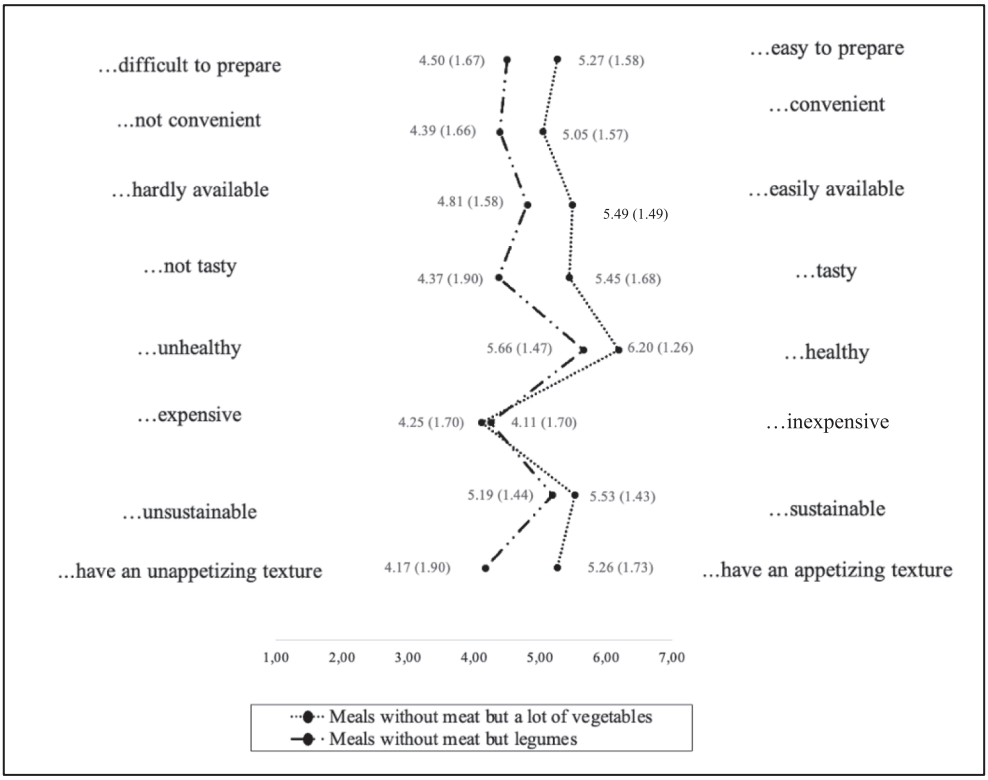

Fig. 1. Consumers' perception of meals with plant-based protein sources *Note.* Means, standard deviations in parentheses, measured on a 7-point semantic differential.

the Danish population in terms of dietary styles, with 79.8% of the sample stating to follow an omnivore diet, 18.4% stating to follow a flexitarian diet, and 1.8% stating to never eat any meat. The survey question on consumers' willingness to eat different types of meals with varying amounts of meat and different types of plant-based protein confirmed the findings of previous studies that Danish consumers have a strong preference for meat (Hielkema and Lund, 2021). The willingness to eat was highest for meals with meat (Mean = 6.19, SD = 1.31), followed by meals with smaller portions of meat (Mean = 5.39, SD = 1.7). Interestingly, also meals without meat but vegetables instead (Mean = 4.85, SD = 2.02) received an overall positive mean evaluation. Out of the two meals with plant-based protein sources instead of meat, meals with legumes were preferred (Mean = 3.76, SD = 2.18) over meals without with meat alternatives that mimic meat in terms of taste, texture, and appearance (Mean = 3.15, SD = 2.02), which is in line with previous studies (Faber et al., 2021).

Consumers' perception of legumes was further measured on bipolar semantic differential scales for different attribute dimensions (see Fig. 1 for the graphical overview). In addition, consumers' perception of a meal without meat but with a lot of vegetables (which is an alternative that consumers presumably are more familiar with) was measured with the same scale, providing a point of comparison to better understand consumers (lack of) capabilities and opportunities to consume legumes.

Except for the perceived cost attribute ("expensive / inexpensive"), meals with legumes score significantly lower on all attributes (paired t-tests, $p < 0.001$) and are perceived as more difficult to prepare, less convenient, less available, less tasty, less healthy, less sustainable, and having a less appetizing texture compared to meals with vegetables.

3.3. Sub-conclusion – Study 1

The pre-study revealed a number of potential leverage points for supermarket interventions, pertaining to the perceived availability, convenience, and ease of preparation of legumes. Danish supermarkets offer a variety of legumes, mostly pre-cooked in cans, jars and composite cartons, or in dried form. The survey results suggest, however, that many consumers are not aware of the wide availability of legumes in supermarkets. A possible explanation could be that legumes are commonly placed on a shelve alongside with other non-perishable products in aisles with relatively low customer traffic. Perceived lack of convenience and ease of preparation turned out to be other important barriers. These might be counteracted by interventions promoting pre-cooked legumes instead of dried legumes (tested in study 2 and 3), and inspiring consumers with recipe suggestions for easy and quick meals might be a way to overcome these barriers (tested in study 3).

4. Study 2 – Randomised controlled trials in a real online grocery store

This study tested the effectiveness of an intervention aiming to increase the perceived availability and visibility of legumes at the point of purchase, in order to overcome primarily opportunity-related barriers to purchasing legumes. Specifically, the study tested a product placement intervention using randomised controlled trials in a real online grocery store, in which legumes were offered in the vegetable section (Round 1) and in the meat section (Round 2) to attract customers who were not actively looking for legumes during their shop visit.

4.1. Theoretical background – Study 2

Retailers' decisions on how to design the choice architecture in the store environment strongly influence consumers' purchasing behaviour (Thaler & Sunstein, 2008) and thus offer potential to foster sustainable choices by providing individuals with easier opportunities to encounter such products. One way how retailers commonly promote products is through prominent placement in special displays and at end-of-aisle shelves. Another way of influencing consumer purchases are the different strategies of how to structure the assortment, i.e. which

products to put together on the shelves. Most supermarkets in Western countries are organised in sections along the typical product categories (e.g., vegetables, meat, dairy, and the different sections of non-perishable products). The increasing product differentiation of alternative protein sources (Zühlsdorf, 2024) raises the question of where to place these products in the stores. The different types of plant-based protein products have a different history in countries like Denmark. Legumes have been part of the assortment of modern supermarkets since the beginning, usually being placed in a section together with other non-perishable products. Products like tofu and tempeh were introduced a few decades ago, mostly placed in the cooling section, whereas highly processed meat substitutes are a newer addition to the assortment.

Only a few studies have investigated the effects of different placement strategies for plant-based protein alternatives based on field experiments in real supermarkets. The existing studies focused mostly on highly processed meat substitutes and tested the effects of placement strategies in the meat section, placing meat substitutes in a newly created bay within the meat aisle (Piernas et al., 2021) or next to their animal-based counterpart (Coucke et al., 2022; van der Meer et al., 2025). The three studies showed an increase in sales of meat substitutes, albeit no decrease in meat sales. To the best of our knowledge, evidence is scarce regarding placement strategies for legumes. Legumes are being perceived differently from meat substitutes (Hueppe & Zander, 2025), which is why they might require differentiated placement strategies beyond side-by-side placement with meat.

Our research investigates the effectiveness of placement interventions for legumes. In Danish supermarkets, legumes are commonly placed in a shelve with other non-perishable products in aisles with relatively low customer traffic. We tested the effectiveness of additionally placing legumes in supermarket sections with high customer traffic. Consumers often shop with meal components in mind, typically including vegetables, carbohydrates, and a protein source (Douglas & Nicod, 1974; Schösler et al., 2012) - which is why we chose the vegetable section (Round 1) and the meat section (Round 2) as intervention points for the randomised controlled trials. The vegetable section was expected to be a promising intervention point, since many consumers perceive legumes to be similar to vegetables (Röös et al., 2022). The meat section, on the other hand, was interesting as a test section for legumes to see whether the same placement strategy can be applied as for meat substitutes.

4.2. Methodological approach – Study 2

Data was collected with randomised controlled trials in collaboration with the Danish online supermarket nemlig.com. This retailer does not have any brick-and-mortar stores but operates fully online with door delivery seven days a week. The minimum order is 500 Danish crowns (approx. 67 Euros); the delivery fee varies from 0 to 69 Danish crowns, depending on the time of day and the geographical location. The delivery area covers large parts of the country, however, nemlig.com customers are primarily located in larger cities. Families with children and households with older people are overrepresented among the customers.

The online store assortment resembles other Danish supermarkets and includes fresh food, frozen food, non-perishable food, beverages (including alcohol), household cleaning products, and personal care products. The online store is organised in typical grocery sections on the menu bar (fruit & vegetables; meat; fish; dairy; etc.). The price level is in the mid-range of Danish supermarkets, similar to brick-and-mortar stores with comparable assortments.

In the usual store set-up, legumes are found in the section "kolonial" which translates to non-perishable or dry foods. The "kolonial" section is placed towards the bottom end in the overview of food sections (see Fig. 2), close to the "flowers & plants", "household, cleaning & living", and "drinks" sections. Customers in the control group could add legumes to their basket through the "kolonial" section and through using the search function. Customers in the treatment group were exposed to an *additional* entry point for adding legumes to their basket, in the form of a placement intervention in the vegetable section and the meat section, respectively. The vegetable and the meat sections are the first two sections in the list of food sections.

The placement intervention for legumes was a so-called "one-row", highlighted with a matte green frame (see Fig. 3), duplicating the six top selling legume products. All other features (prices, availability, search function results, etc.) were identical across the control and the treatment group. The legume row was placed as the third row from the top on the

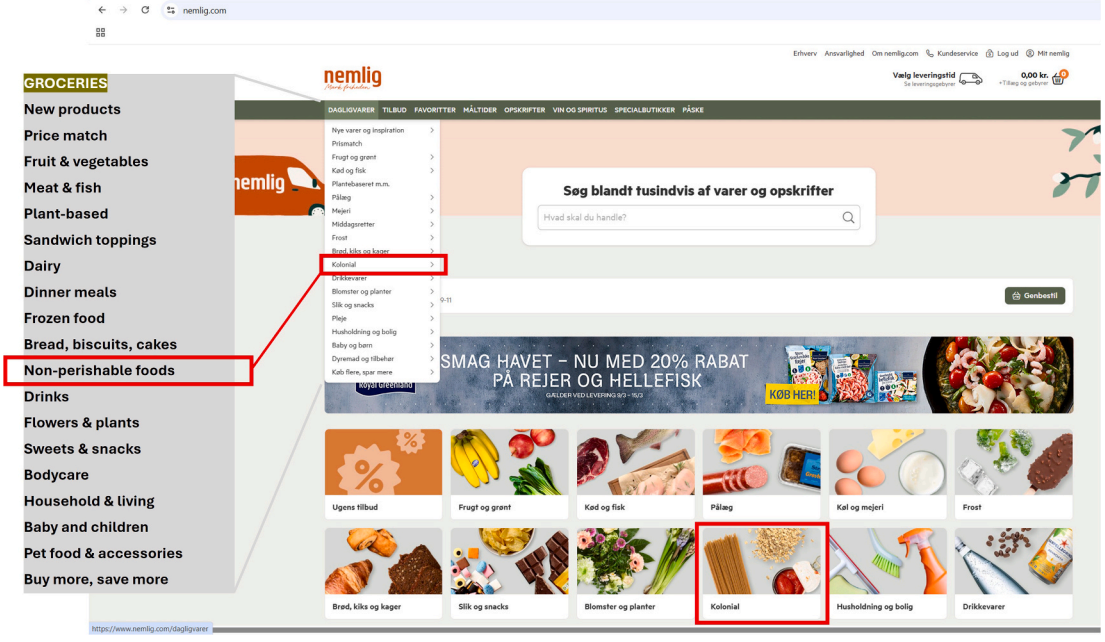

Fig. 2. Landing page of the online supermarket. *Note.* The food section highlighted in red ("Kolonial"/"Non-perishable foods") is where legumes are located. In the treatment group, six legume products were additionally placed in the vegetable section and the meat section, respectively. Food section names translated into English by the authors.

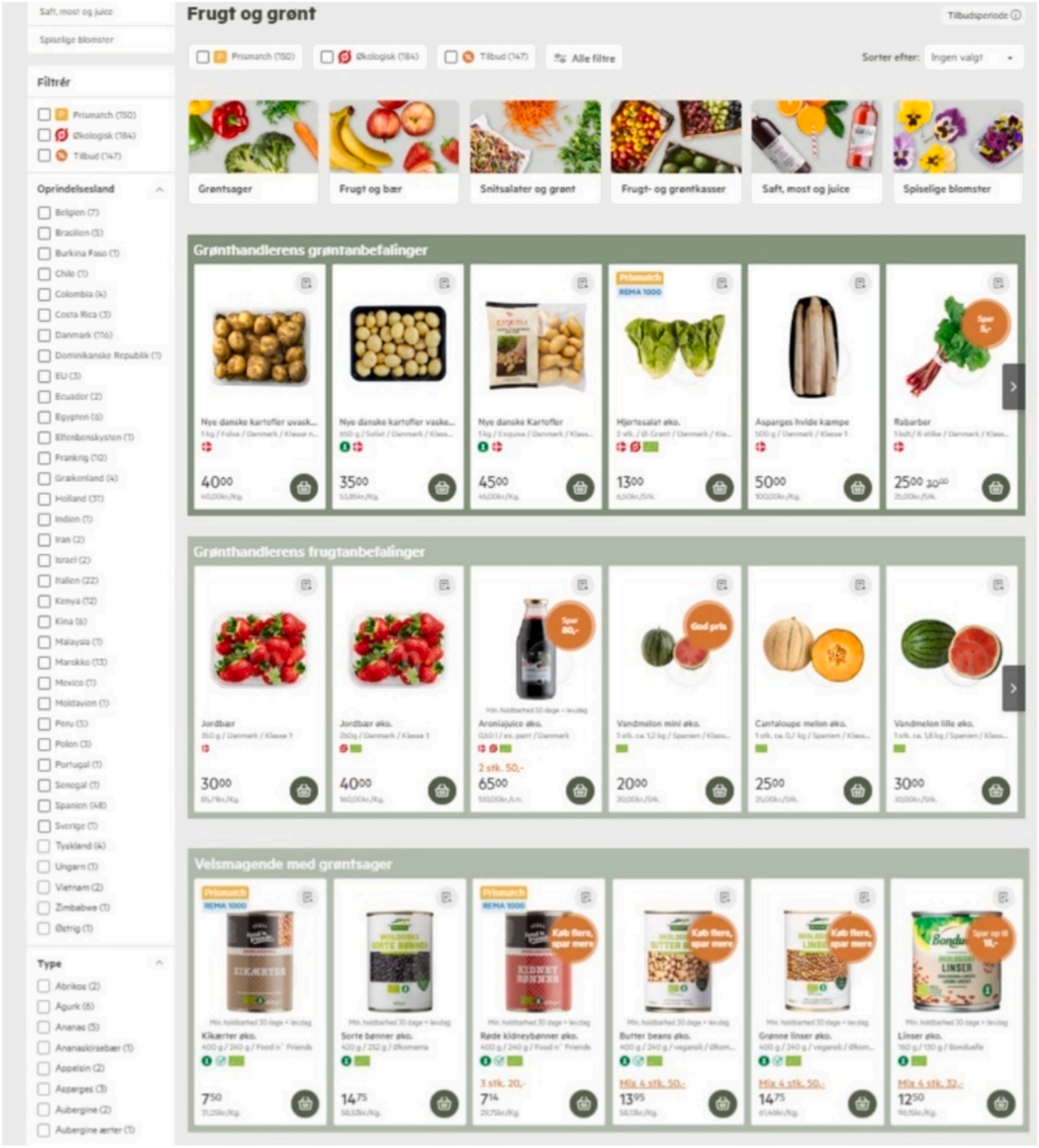

Fig. 3. Placement intervention for legumes in the vegetable section.

landing page of the vegetable section and the meat section, respectively. All main rows on the landing page typically have a heading. The one-row of legumes in the vegetable section was titled 'Tasty with vegetables', to communicate that legumes should be included in a meal in addition to, and not instead of vegetables. The heading of the legume row in the meat section was titled 'Tasty alternatives', to convey the message that legumes should replace rather than complement meat in a meal (see Table 1).

Two rounds of randomised controlled trials were conducted in summer 2023 to test the effectiveness of the placement interventions for legumes with an A/B-testing procedure over three weeks. In round 1, store visitors of the vegetable section were randomly directed either to the usual vegetable section (control group) or the vegetable section with the legume row (treatment group). The same procedure was repeated for the placement intervention on the meat page over a three-week period (Round 2) after a six-week washout period. A/B-testing was limited to store visitors who had accepted the use of marketing cookies. The A/B-

Table 1
Structure of the experimental design.

	Round 1	Round 2
Intervention point	Vegetable section	Meat section
Translation of the one-row heading	Tasty with vegetables	Tasty alternatives
Control group	No legumes in vegetable section	No legumes in meat section
Intervention period	June 12, 2023 – July 3, 2023	August 14, 2023 – September 3, 2023

testing algorithm made sure that customers would always be in the same experimental group also when visiting the store several times during the trial period.

In the dataset, the unit of observation is the transaction. The A/B test includes transactions generated from sessions (i.e., store visits) in which the target page was visited, defined as the vegetable section in the first round and the meat section in the second round of data collection. The following information is available for each transaction: date, group (i.e., control or treatment group), and whether the transaction included at least one target product (i.e. products included in the legume row). The data do not contain customer identifiers, so transactions cannot be linked across individuals. We estimated the treatment effect of the placement intervention on the likelihood that a transaction contains a legume product using transaction-level logistic regression models with date fixed effects.

The baseline specification is given by:

$$\Pr(Y_{it} = 1) = \text{logit}^{-1}(\alpha + \beta \cdot \text{Treatment}_i + \gamma_t)$$

where Y_{it} is a binary indicator equal to one if transaction i on date t contains a legume product. Treatment_i is an indicator for the treatment group, and γ_t denotes date fixed effects that control for time-varying factors common to all transactions.

To examine how the treatment effect evolves over time, we estimate an extended specification that interacts the treatment indicator with week dummies:

$$\Pr(Y_{it} = 1) = \text{logit}^{-1}\left(\alpha + \beta \cdot \text{Treatment}_i + \sum_w \delta_w \cdot (\text{Treatment}_i \times \text{Week}_w) + \gamma_t\right)$$

This specification allows the treatment effect to vary across weeks of the intervention, with the baseline effect corresponding to the first week. All models are estimated in R using the *fixest* package. Standard errors are heteroskedasticity-robust. Because the data do not contain customer identifiers, it is not possible to cluster standard errors at the customer level. However, since customers usually shop at the online supermarket no more than once per week, repeated purchases by the same individual are likely limited. As a result, concerns about within-customer correlation, and the potential understatement of standard errors, are likely to be limited in this context. In addition to the transaction data, the partner store provided the following data (differentiated by control group and treatment group): number of sessions per day, frequency distribution of number of target products sold during the trial period, number of transactions containing vegetables and number of transactions containing meat during the trial period.

4.3. Results – Study 2

The randomised controlled trials encompassed more than 40,000 sessions per round of data collection, corresponding to n = 9,093 transactions in Round 1 (intervention in the vegetable section) and n = 8,706 transactions in Round 2 (intervention in the meat section).

Table 2 reports the estimates from the logistic regression models with date fixed effects for the placement intervention in the vegetable section. The baseline specification shows a positive and statistically significant treatment effect (Treatment coefficient = 0.447, p = 0.001, odds ratio = 1.56).

The placement intervention in the vegetable section raised the likelihood that a transaction contained a legume target product from 1.93% to 2.98% (Table 3), corresponding to an increase of 1.05 percentage points. Allowing the treatment effect to vary over time in the dynamic model yields a similar result. The estimated marginal effects indicate an increase in transactions containing a legume target product of 1.71 percentage points in week 1 and 1.48 percentage points in week 2, declining to 0.47 percentage points in week 3. However, the differences across weeks are not statistically significant (as the interaction terms between the treatment indicator and the week dummies are not statistically significant).

Table 2
Logistic regression models on placement intervention for legumes in the *vegetable section.*

	Baseline model			Dynamic model		
	Coeff.	Std. error	p-value	Coeff.	Std. error	p-value
Treatment	0.447	0.139	0.00132 **	0.654	0.269	0.01518 *
Treatment: Week 2				−0.068	0.378	0.858
Treatment: Week 3				−0.431	0.340	0.205

Note. Binary logistic regression date fixed-effects models, heteroskedasticity-robust standard errors, N = 9.093 transactions. Outcome variable: 'Legume target product in transaction' (yes / no). Treatment: Placement of a one-row with six legume products in the vegetable section (yes / no).

Table 3
Proportion of transactions containing a legume target product.

	Control Group	Treatment Group
Placement intervention in the *vegetable section* (Round 1)	1.93%	2.98%
Placement intervention in the *meat section* (Round 2)	2.67%	2.57%

Overall, the results provide evidence of a positive treatment effect of the placement intervention in the vegetable section, with suggestive but statistically inconclusive evidence of a fading effect over time. Among the transactions that included legume target products, the mean number of legume target products purchased was not significantly different between the two groups (2.80 in the control group and 2.57 in the treatment group, *t*-test, $p = 0.51$), indicating that customers exposed to the placement intervention in the vegetable section bought similar quantities as those in the control group. The proportion of transactions containing vegetables was not significantly affected by the legume placement intervention (59.0% in the control group versus 59.7% in the treatment group), indicating that people did not substitute vegetables with legumes. The share of transactions containing meat decreased from 35.3% in the control group to 34.8% in the treatment group, however, this difference was not statistically significant.

In contrast to the intervention in the vegetable section, the legume placement in the meat section did not have any statistically significant

Table 4
Logistic regression models on placement intervention for legumes in the meat section.

	Baseline model			Dynamic model		
	Coeff.	Std. error	p-value	Coeff.	Std. error	p-value
Treatment	−0.037	0.135	0.78125	−0.036	0.258	0.88854
Treatment: Week2				−0.146	0.337	0.66463
Treatment: Week3				0.160	0.347	0.64423

Note. Binary logistic regression date fixed-effects models, heteroskedasticity-robust standard errors, N = 9.093 transactions. Outcome variable: 'Legume target product in transaction' (yes / no). Treatment: Placement of a one-row with six legume products in the meat section (yes / no).

effects, neither in the baseline model nor when allowing the treatment effect to vary over time (Table 4). The share of transactions with legume target products amounted to 2.67% in the control group compared to 2.57% in the treatment group. The share of transactions with meat were also equal in both groups (39.9% in the control group versus 39.7% in the treatment group).

4.4. Discussion – Study 2

The results of the randomised controlled trials underline the important influence of supermarket choice architecture on consumers' food purchasing behaviour. The key finding is that exposure to legumes alone does not increase sales; the effectiveness of the placement intervention depends on the context, more specifically, the product section. An increase in legume sales was observed only when legumes were placed in the vegetable section, not when they were placed in the meat section. Previous studies found increased sales of meat substitutes when they were positioned next to or near their animal-based counterparts (Coucke et al. 2022; van de Meer et al., 2025). Applying the same placement strategy to legumes, however, does not appear to be effective according to our results as well as the study by Wolfswinkel et al. (2025). Thus, the effectiveness of increasing visibility and salience to enhance consumers' opportunity to purchase legumes appears to depend on the context, i.e., in which store section the intervention is implemented).

The reasons for the different effects observed between the intervention on the vegetable page and the intervention on the meat page remain unclear in our study. We do not have additional data about the individual transactions; hence lack further information about the legume buyers in terms of how much legumes they usually buy. Still, it is worthwhile relating our findings to previous research on consumer perceptions of legumes. Categorisation theory (Loken et al., 2008) suggests that consumers make sense of products by sorting them into familiar product categories. Legumes, however, are a product category that many consumers do not have on their radar. As such, the recent heightened focus on legumes, e.g. in the official Danish dietary guidelines, is unfamiliar to many consumers in Denmark.

According to previous studies, consumers do not clearly associate beans and nuts with proteins (van der Meer et al., 2023), underlining the notion that many consumers do not clearly understand the role of legumes as a protein source and possible alternative to meat. Many consumers perceive legumes as something completely different from meat, which might explain why the placement intervention in the meat section was neither effective in our study nor in the study by Wolfswinkel et al. (2025). Further research is needed to uncover the underlying reasons. Overall, our results suggest a good perceived fit of positioning legumes in the vegetable section, while consumers are not open to adding legumes to their basket when browsing through the meat section.

5. Study 3 – Field experiments in brick-and-mortar grocery stores

This study aims to address capability- and opportunity-related barriers to purchasing legumes in a physical retail setting. It focuses on reducing consumers' perceived capability-related barriers to preparing legumes (e.g., perceived lack of cooking skills), and increasing individuals' opportunity by enhancing the availability and visibility of legumes. More specifically, the multi-layered intervention tested in this study consisted of the following elements (see Fig. 1): a display in the vegetable section of the intervention supermarkets with a poster designed to inspire consumers to prepare a simple vegetarian meal with legumes (to address capability-related barriers), and a so-called bundling placement of the ingredients needed for the recipe (to address opportunity-related barriers).

5.1. Theoretical background on consumer inspiration – Study 3

To overcome important barriers to legume consumption, providing consumers with recipe inspirations has been suggested in previous research (Melendrez-Ruiz et al., 2019; Whittall et al., 2024). Providing consumers with recipe inspirations could overcome consumers' lack of knowledge on how to include legumes in typical meals (Melendrez-Ruiz et al., 2019). Since the average Danish consumer spends 30 min with dinner preparation and 30% spend less than 15 min (Kvist et al., 2022), providing an easy and quick recipe might mitigate consumer concerns not having enough time to prepare legumes. Inspiring consumers at the point of purchase about what food products to buy and which dish to cook holds the potential to foster consumers' exploratory behaviour and influence consumers' purchasing behaviour (Böttger et al., 2017). By inspiring consumers on what to prepare for dinner, consumers' cognitive arising from the large variety of food products in the retail environment might be reduced.

Although rarely investigated scientifically in the field of food sciences, inspiring consumers has a long tradition in marketing (Böttger et al., 2017). Theoretically, consumer inspiration is described as a motivational state that, induced by an external cue, fosters the materialization of new consumption-related goals (Böttger et al., 2017). This makes consumer inspiration a beneficial approach to broaden consumers' horizon about sustainable consumption possibilities and in turn, transition to sustainable consumption behaviour. Inspiration involves three components: transcendence, evocation and motivation. The first means that, initiated by an external cue, consumers perceive the product as something superior than what they usually would buy. Evocation describes the phenomenon that inspiration arises unexpectedly, sparked by an external cue. Lastly, motivation describes the activation of behavioural intentions to put new ideas into action. Following Böttger et al., (2017), an external stimulus, in our case the recipe inspiration, creates a state of inspiration. The feeling of being inspired, in turn, might create a motivational state that has the potential to foster behavioural change, in our case preparing a meal with legumes (Böttger et al., 2017). Some studies have investigated the effect of consumer inspiration in pro-environmental choices in the recycling (Winterich et al., 2019) or tourism domain (Kwon & Boger, 2021), but the full potential of consumer inspiration in transitioning to more sustainable food choices has not been fully tapped (Böttger et al., 2017). To the authors' knowledge, field studies investigating the effectiveness of providing consumers with recipe inspirations in the food retail environment to increase legume consumption are lacking so far.

Due to the highly habituated nature of grocery shopping as well as the time pressure many consumers experience when food shopping, the inspirational potential is more likely to materialize when barriers to behaviour change are low. One approach to support the inspirational external cue is making the products more salient (Bauer et al., 2022). As such, presenting the inspirational cue close at hand to the promoted products seems advisable. In the marketing domain, presenting items together, often in combination with a price discount, has been widely applied and is known as product bundling (Sharpe & Staelin, 2010). In many cases, placing products together creates added value for consumers (Stremersch & Tellis, 2002) and simplifies the shopping experience by making it easier to consider, select and find products, thus reducing search costs and cognitive efforts (Sharpe & Staelin, 2010).

Fig. 4. Experimental set-up in one of the test stores.

5.2. Methodological approach – Study 3

The multi-layered intervention tested in this study consisted of two elements: (1) a poster with a picture of a cooked meal (pasta with pesto and chickpeas[1]), a list of ingredients needed to prepare the meal, a QR-code linking to preparation instructions, and (2) a display presenting the ingredients needed for the recipe (see Fig. 4). The intervention was tested across nine test stores located in different regions of Denmark for one week (7 days) in November 2023. All test stores set up the display at a highly frequented, prominent place in the vegetable section.

In collaboration with the partner retailer, treatment and control stores were selected based on four strata defined by two characteristics: average income (high vs. low) and population density (high vs. low) of the area in which the store is located. To minimise potential biases, the control group was constructed to closely match the composition of the treatment group across these strata. All stores were visited at least once at the beginning of the data collection phase by a member of the research team, to ensure that the display was set up correctly and clarify any open questions from the store managers and employees.

Data analysis is based on aggregated sales data for the legume test product (chickpeas) from the nine test stores and 13 control stores that did not set up the display but were similar to the test stores in terms of average income and population density of the area they are located in. The data is available at store level for each day of the intervention period as well as three weeks before the intervention. A difference-in-difference (DiD) approach (based on Ordinary Least Squares Regression Model) using daily store-level sales data was applied to estimate the average effect of the intervention.

As such, the following model was estimated:

$$Y_{it} = \alpha_i + \delta_t + \beta(\text{TreatmentStore}_i x\, \text{Interventionperiod}_t) + \varepsilon_{it}$$

Y_{it} is the number of chickpea cans sold in store i on day t. Treatment Store is a dummy variable that is equal to 1 for stores assigned to the treatment group and 0 for control stores. Interventionperiod is a dummy equal to 1 for observations during the intervention period. The coefficient β captures the causal effect of the intervention. The model includes store fixed effects (α_i) and time fixed effects (δ_t). Standard errors are clustered at the store level.

The DiD approach is a widely used method for evaluating field experiments without random assignment and has been applied in previous studies with similar data structures (e.g., Bauer et al. 2022). It aligns particularly well with our design, which compares two groups (treatment and control) across two time periods (baseline and intervention) (Lechner, 2010). The DiD approach relies on the parallel trends assumption, which states that in the absence of the intervention, treatment and control units would have followed similar trends in the outcome variable over time. In this context, the counterfactual outcome refers to the level of chickpea sales that treated stores would have experiences had the intervention not taken place. Because this counterfactual outcome cannot be observed after the intervention, the parallel trends assumption cannot be directly tested for the post-treatment period. However, the assumption can be assessed by testing whether treatment and control stores show similar trends in chickpea sales during the pre-treatment period. The null hypothesis of equal pre-treatment trends cannot be rejected at the 5% significance level ($F(1, 21) = 3.17$, $p = 0.0895$), suggesting no statistically significant differences in trends between treatment and control stores prior to the intervention, although the result is marginally significant at the 10% level.

5.3. Results – Study 3

The control and treatment stores differed in several store characteristics, as shown in Table 5. The number of customers, total daily sales and, key to this study, daily chickpeas sales were, on average, higher in the control stores, during both the pre-intervention as well as intervention period. On average, the number of customers and total daily sales decreased slightly in the intervention period for both control and intervention stores. The baseline sales levels of legumes were comparably low in all stores. While intervention stores sold an average of 7.12 cans of chickpeas per day in the pre-intervention period, control stores sold 13.75. However, the descriptive results already point to an increase

Table 5
Descriptive Statistics.

	Pre-intervention period		Intervention period	
	Control-Stores	Treatment-Stores	Control-Stores	Treatment-Stores
Average number of customers *per day*	1561.31 (454.46)	1276.35 (199.44)	1489.38 (440.1)	1229.06 (199.01)
Average daily sales *total, in dkk*	243464.81 (86941.02)	222768.63 (66829.68)	235141.03 (92266.99)	218729.0 (740666.49)
Average daily chickpea sales *in cans*	13.75 (14.02)	7.12(5.64)	12.26 (12.63)	9.38 (7.79)
Days of observation	21	21	7	7

Note. Pre-intervention period: week 43, 44, 45 in 2024, Intervention week 46 in 2024, Standard deviations in parentheses.

[1] Based on extensive discussions with experts in Danish food culture and the plant-based transition, this specific meal was selected for its quick and easy preparation and strong appeal to the broad majority of Danish consumers.

Table 6
Effects of intervention on chickpea sales (in cans per day and store).

	Chickpea sales	
	Coefficient (Std. Error)	*p*-value
Intervention Period	−1.49 (0.84)	0.077
Treatment Store x Intervention Period	3.75 (1.35)	0.004

Notes. All estimates based on OLS regression. The model includes store and time fixed effects. Standard errors were clustered on the store level.

in chickpea sales in the treatment stores during the intervention period, while sales of chickpeas decreased slightly in control stores over the same period.

The results of the DiD analysis indicate that the intervention significantly increased chickpea sales (see Table 6). The coefficient for the intervention period suggests that chickpea sales in control stores declined slightly during the intervention period (β = -1.49, p = 0.077). The interaction term between Treatment Store and Intervention Period captures the treatment effect. The results show that, during the intervention period, treatment stores sold on average 3.75 more cans of chickpeas per day relative to the change observed in control stores (β = 3.75, p = 0.005). This indicates that the intervention led to a statistically significant increase in chickpea sales in treatment stores.

5.4. Discussion – Study 3

This study provides empirical evidence supporting earlier propositions (Melendrez-Ruiz et al., 2019; Whittall et al., 2024) that providing recipe inspirations in food retailing to increase legume sales and overcome capability-related barriers. Overall, our results showed that inspiring consumers and simplifying consumers' choice significantly increased the sales of legumes in the nine test stores. Results from an in-store survey conducted in one of the test stores during the intervention period support the assumption that offering a recipe for an easy and quick meal with legumes can mitigate some of the main barriers to legume purchase and consumption reported in the literature, such as a lack of cooking skills and time to prepare dishes with legumes (Whittall et al., 2024). Concerns about the taste of legumes (Böttger et al., 2017) can be addressed by providing a picture of the dish, helping to create positive associations with a tasty meal. Our observations are limited to a one-week period but it is likely that consumer interest would decline over time if recipes and products were not changed frequently (Moran et al., 2019). Providing consumers with new meal inspirations on a regular basis could maintain awareness and provide consumers with a variety of legume-based recipes; however, more research is needed to understand whether these measures can contribute to lasting shifts in consumer habits.

6. Conclusions

The present research investigated whether supermarket interventions might be a promising lever to increase purchases of legumes and thereby contribute to narrowing the gap between actual and recommended consumption levels of legumes. Based on the literature on choice architecture and behaviour change, we tested two types of interventions, a placement intervention targeting opportunity-related barriers, and a multi-layered intervention combining a recipe inspiration poster with a bundling placement aiming to overcome capability- and opportunity-related barriers.

We found that the effectiveness of placement interventions for legumes appears to depend on the context,i.e., the store section where the intervention is implemented.. Our findings suggest that interventions in the vegetable section have the potential to succeed in increasing sales with legumes, while this does not seem to be the case for interventions in the meat section. While our data do not allow us to directly identify underlying mechanisms, survey results from study 1 provide insights into possible explanations. Our survey results suggest that consumers may not strongly associate legumes with proteins (van der Meer et al., 2023) but perceive them to be similar to vegetables (Röös et al., 2022). In addition, respondents viewed legume-based meals as more effortful and less convenient than vegetable-based meals, while perceived differences in healthiness and price were comparatively small. Consumers in the vegetable section are therefore likely already oriented toward preparing vegetables as part of everyday meals. Placing legumes in this section may facilitate their consideration as a regular meal component. In contrast, the meat section may activate expectations centered around animal protein as the main component of the meal. Consumers who are not actively seeking meat alternatives may therefore find legumes in this section incongruent, as legumes are typically perceived as a side dish rather than a main component.

Our research underlines that retailers play a key role in shaping food consumption through the way the store environment is organised. We found that retailers have the potential to increase legume sales through (multi-layered) placement interventions, supporting the notion put forward by previous authors (Moran et al., 2019) that interventions promoting food choices in line with the planetary health diet do not necessarily require monetary incentives to be effective. The interventions tested in our study involved low costs and were relatively easy to implement. Overall, placement interventions for legumes in the vegetable section may therefore be considered a cost-effective strategy. The results of our field experiments demonstrate that in-store interventions are an effective strategy for significantly increasing the legume sales by a factor of around 1.5 over the intervention period of three weeks (Study 1) and one week (Study 2), respectively. Further research is needed to investigate the longevity of the interventions tested, i.e. whether sales will remain at a higher level if the interventions are permanently implemented.

While the observed increases in legume sales are statistically significant with large effect sizes, the absolute numbers of legume products sold remain at a low level. Given the large number of daily store visits in a typical supermarket, an increase in 3–4 additional cans per day and store corresponds to only a very small behavioural change at the individual customer level. From a commercial perspective, retailers may therefore question whether allocating scarce promotional display space to legumes is beneficial compared to other product categories that generate larger sales. As such, legumes compete with other product categories for limited shelf space and promotional display space. Promotional displays are more effective for vice products than for virtue products, such as legumes. Promotional displays rely on impulse buying and visual appeal, more likely to be triggered for vice products that provide immediate reward and require low cognitive effort (Wertenbroch, 1998). Meat products represent a prominent example of such products, as they are often associated with taste, sensory pleasure, and immediate gratification. Virtue products such as legumes, by contrast, do not offer immediate gratification and require rather deliberate decision-making. In this context, it is remarkable that the interventions for legumes in the vegetable section proved effective in our studies, even without a price or quantity discount. Importantly, while the observed behavioural changes at the individual level are small, even modest shifts in purchasing behaviour can translate into meaningful changes in food consumption patterns at the population level when interventions are implemented across many stores and over longer periods of time.

It is further important to recognize that the objectives of retailers and public policy do not necessarily coincide. Retailers primarily evaluate interventions based on their profitability, whereas policymakers may consider even small behavioural shifts valuable if they contribute to broader societal goals such as improving dietary patterns. Thus, the findings of this study demonstrate that even small adjustments to the retail environment can influence consumer behaviour, even in the absence of financial incentives. The present study should, however, be interpreted as providing evidence on the effectiveness of placement and

promotion interventions under the assumption that retailers are willing to actively support a shift toward more sustainable protein sources. As such, the findings are particularly relevant for retailers and policymakers seeking to align commercial practices with sustainability objectives.

Despite the promising increases in legume sales observed in our two field studies, it needs to be acknowledged that the interventions tested did not affect the meat sales. However, it was never expected that the interventions would have the power to decrease meat sales, given the low level of legume consumption in Denmark, and the relatively small scope of the interventions. Moreover meat consumption is deeply embedded in cultural practices (Leroy & Praet, 2015) and associated with strong hedonic appeal, making substitution particularly challenging. For scaling up the protein transition, researchers and retailers should work towards designing and testing ambitious large-scale interventions for legumes and other alternative proteins.

7. Policy implications

The increasing urgency of transitioning to a more sustainable food system has led to national and EU-wide policy initiatives focusing on increasing the intake of plant-based proteins. While particular emphasis has been placed on legumes, actual consumption levels in most European countries remain below the recommendations of national and international dietary guidelines.

The retail environment represents a promising arena for influencing food choices and thereby supporting public policy objectives. However, limited shelf and promotional display space as well as fierce competition underscore a central challenge: public health goals are not the primary objectives of private market actors (SAPEA, 2020). Policy intervention therefore appear necessary.

At the same time, the small absolute increases in sales of legumes observed in our field experiments suggest that such interventions alone are unlikely to lead to large changes in dietary behaviour at population level in a short period of time. As discussed above, the increase in sales corresponds to only a small behavioural shift among few individual consumers. Thus, the results should not be interpreted as evidence that simple placement interventions can meaningfully drive the broader "protein transition" on their own. Rather, the findings highlight that food retail environments represent one of several potential levers that could contribute to normalising the consumption of plant-based protein sources. From a policy perspective, the results illustrate a structural challenge: while retail environments offer opportunities to influence food choices, supermarkets operate under commercial constraints, including limited shelf space and strong competition between product categories. Public health and sustainability goals are therefore not always aligned with retailers' incentives. For this reason, policymakers have increasingly begun to consider how retail environments might be shaped through policy instruments. Examples such as the restriction of promotions and specified in-store placements for unhealthy foods in the UK (UK food Promotion and Placement regulation [SI 2021 No. 1368]) already demonstrate the potential of altering food environments to achieve public policy objectives. However, comparable policy instruments that actively promote sustainable foods, and in particular legumes, in retail environments remain rare.

Given the modest effects observed in the present study, our findings should primarily be interpreted as initial evidence regarding the potential role of retail environments in supporting plant-based protein consumption. Future policy initiatives for encouraging retailers to actively support the promotion of legumes and other plant-based proteins may come in different forms, e.g. regulatory restrictions for promotion and placement (like the UK food Promotion and Placement regulation [SI 2021 No. 1368]), incentive structures, such as fiscal benefits or sustainability-linked subsidies, or public–private partnerships (like the wholegrain partnership in Denmark[Schulze et al., 2024]). Different countries may need different policy approaches. Future research should investigate which type of policy intervention would be appropriate in different countries. An additional consideration concerns the broader policy landscape in the EU. While recent national and EU initiatives emphasize increasing plant-based protein consumption, European agricultural policy simultaneously provides strong legal protection for traditional foods through Geographical Indication schemes. Many of these protected products (e.g., cheeses and processed meats) are animal-based and form an important part of European agricultural policy and cultural heritage. This creates a potential policy tension between initiatives encouraging reduced consumption of animal proteins and policies supporting traditional animal-based products. Future research could examine how sustainability-oriented dietary policies interact with these existing agricultural and cultural protection frameworks.

8. Limitations

As with any research, the studies presented here have limitations that need to be considered when interpreting the results. A key challenge concerns our objective of contributing to closing the gap between actual and recommended consumption levels of legumes. While we examine supermarket interventions as a lever to increase purchases, our data capture purchasing behavior rather than actual consumption. We therefore cannot directly assess whether increased purchases translate into higher consumption levels.

Another challenge of the field studies is that we lack further information about the customers who bought legume products in the intervention groups. As such, our data lacks information on whether the intervention attracted consumers who are already interested in plant-based protein sources. Moreover, the transition towards a sustainable food system requires changes in consumers' lifestyle and habits. The results of this study provide no insight into long-term behavioural shifts. A further limitation relates to the scope of the behavioural mechanisms targeted by the interventions. While the study draws on the COM-B framework, the interventions primarily address capability- and opportunity-related barriers by increasing the visibility and accessibility of legumes in the retail environment. They do not directly target motivational factors related to hedonic preferences, such as taste perceptions or anticipated enjoyment, which are known to be key drivers of food choice. As discussed in the theoretical framework, these hedonic and culturally embedded preferences, particularly in relation to meat consumption, may represent a substantial barrier to the uptake of plant-based protein sources. Future research could therefore explore interventions that explicitly address such motivational drivers, for instance by combining placement strategies with sensory cues, tasting opportunities, or marketing approaches aimed at enhancing the perceived palatability of legumes.

CRediT authorship contribution statement

M. Schulze: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Meike Janssen:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

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References

Ammann, J., Arbenz, A., Mack, G., Siegrist, M., 2025. Consumer support of policy measures to increase sustainability in food consumption. Food Policy 131, 102822. https://doi.org/10.1016/j.foodpol.2025.102822.

Bælgfrugtspartnerskabet. (n.d.). Bælgfrugtspartnerskabet. https://www.baelgfrugtspartnerskabet.dk/om-bfp.

Bauer, J.M., Aarestrup, S.C., Hansen, P.G., Reisch, L.A., 2022. Nudging more sustainable grocery purchases: Behavioural innovations in a supermarket setting. Technol. Forecast. Soc. Chang. 179, 121605. https://doi.org/10.1016/j.techfore.2022.121605.

Böttger, T., Rudolph, T., Evanschitzky, H., Pfrang, T., 2017. Customer inspiration: conceptualization, scale development, and validation. J. Mark. 81 (6), 116–131. https://doi.org/10.1509/jm.15.0007.

Carroll, K.A., Samek, A., 2018. Field experiments on food choice in grocery stores: a 'how-to' guide. Food Policy 79, 331–340. https://doi.org/10.1016/j.foodpol.2018.03.004.

Chu, J., Arce-Urriza, M., Cebollada-Calvo, J.-J., Chintagunta, P.K., 2010. An empirical analysis of shopping behavior across online and offline channels for grocery products: the moderating effects of household and product characteristics. J. Interact. Mark. 24 (4), 251–268. https://doi.org/10.1016/j.intmar.2010.07.004.

Coucke, N., Vermeir, I., Slabbinck, H., Geuens, M., Choueiki, Z., 2022. How to reduce agri-environmental impacts on ecosystem services: the role of nudging techniques to increase purchase of plant-based meat substitutes. Ecosyst. Serv. 56, 101444. https://doi.org/10.1016/j.ecoser.2022.101444.

Danish Ministry of Food, Agriculture and Fisheries, 2023. Strategy for green proteins for animals and humans. https://fvm.dk/Media/638465337572572884/Strategi-for-groenne-proteiner-digital-23-11-2023.pdf.

Danish Veterinary and Food Administration, 2025. The Official Dietary Guidelines – good for health and climate. https://en.foedevarestyrelsen.dk/food/nutrition-and-health/the-official-dietary-guidelines.

Dhar, S.K., Hoch, S.J., Kumar, N., 2001. Effective category management depends on the role of the category☆. J. Retail. 77 (2), 165–184. https://doi.org/10.1016/S0022-4359(01)00045-8.

Douglas, M., Nicod, M., 1974. Taking the biscuit: the structure of British meals. New Society 744–746.

European Commission, 2020. A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381.

Faber, I., Henn, K., Brugarolas, M., Perez-Cueto, F.J., 2022. Relevant characteristics of food products based on alternative proteins according to European consumers. J. Sci. Food Agric. 102 (12), 5034–5043. https://doi.org/10.1002/jsfa.11178.

Federal Ministry of Food and Agriculture, 2020. Ackerbohne, Erbse & Co. – Die Eiweißpflanzenstrategie des Bundesministeriums für Ernährung und Landwirtschaft zur Förderung des Leguminosenanbaus in Deutschland. https://www.bmel.de/SharedDocs/Downloads/DE/_Landwirtschaft/Pflanzenbau/EiweisspflanzenstrategieBMEL.htmlthuenen.de+5bmel.de+5ble.de+5.

Font-i-Furnols, M., Guerrero, L., 2025. An overview of drivers and emotions of meat consumption. Meat Sci. 219, 109619. https://doi.org/10.1016/j.meatsci.2024.109619.

Furst, T., Connors, M., Bisogni, C.A., Sobal, J., Falk, L.W., 1996. Food choice: a conceptual model of the process. Appetite 26 (3), 247–266. https://doi.org/10.1006/appe.1996.0019.

Graça, J., Godinho, C.A., Truninger, M., 2019. Reducing meat consumption and following plant-based diets: current evidence and future directions to inform integrated transitions. Trends Food Sci. Technol. 91, 380–390. https://doi.org/10.1016/j.tifs.2019.07.046.

Hansen, P.G., Jespersen, A.M., 2013. Nudge and the manipulation of choice: a framework for the responsible use of the nudge approach to behaviour change in public policy. Eur. J. Risk Regul. 4 (1), 3–28. https://doi.org/10.1017/S1867299X00002762.

HDE (Handelsverband Deutschland), 2025. HANDELSREPORT FRISCHE LEBENSMITTEL. https://einzelhandel.de/images/publikationen/Handelsreport_Frischelebensmittel_2025.pdf.

Henn, K., Goddyn, H., Olsen, S.B., Bredie, W.L.P., 2022. Identifying behavioral and attitudinal barriers and drivers to promote consumption of pulses: a quantitative survey across five European countries. Food Qual. Prefer. 98, 104455. https://doi.org/10.1016/j.foodqual.2021.104455.

Hielkema, M.H., Lund, T.B., 2021. Reducing meat consumption in meat-loving Denmark: Exploring willingness, behavior, barriers and drivers. Food Qual. Prefer. 93, 104257. https://doi.org/10.1016/j.foodqual.2021.104257.

Holtrop, N., Lobschat, L., ter Braak, A., 2025. Paving the way for responsible retailing. J. Retail. 101 (1), 1–6. https://doi.org/10.1016/j.jretai.2025.02.006.

Hueppe, R., Zander, K., 2025. Legume consumption and sustainability – the minority goes green. Appetite 206, 107831. https://doi.org/10.1016/j.appet.2024.107831.

Kahneman, D., 2013. Thinking, fast and slow (First paperback edition). Farrar, Straus and Giroux.

Kvist, R. L., Strømsted, K. I., Madsen, S. N., Liebst, L., Berthelsen, A. H., & Hoff, H., 2022. Madkulturens årlige befolkningsundersøgelse af danskernes mad og måltidsvaner—2022. https://www.madkulturen.dk/viden/madkultur22/.

Kwon, J., Boger, C.A., 2021. Influence of brand experience on customer inspiration and pro-environmental intention. Curr. Issue Tour. 24 (8), 1154–1168. https://doi.org/10.1080/13683500.2020.1769571.

Lechner, M., 2011. The estimation of causal effects by difference-in-difference methods. Found. Trends in Econom. 165–224.

Loken, B., Barsalou, L. W., & Joiner, C., 2008. Categorization Theory and Research in Consumer Psychology: Category Representation and Category-Based Inference. In Handbook of Consumer Psychology. Taylor & Francis Group. https://carlsonschool.umn.edu/sites/carlsonschool.umn.edu/files/2020-03/loken%20barsalou%20joiner%20handbook%20of%20cp.pdf.

Leroy, F., Praet, I., 2015. Meat traditions. The co-evolution of humans and meat. Appetite 90, 200–211. https://doi.org/10.1016/j.appet.2015.03.014.

Machín, L., Curutchet, M.R., Gugliucci, V., Vitola, A., Otterbring, T., De Alcantara, M., Ares, G., 2020. The habitual nature of food purchases at the supermarket: Implications for policy making. Appetite 155, 104844. https://doi.org/10.1016/j.appet.2020.104844.

Melendrez-Ruiz, J., Buatois, Q., Chambaron, S., Monnery-Patris, S., Arvisenet, G., 2019. French consumers know the benefits of pulses, but do not choose them: an exploratory study combining indirect and direct approaches. Appetite 141, 104311. https://doi.org/10.1016/j.appet.2019.06.003.

Michie, S., Van Stralen, M.M., West, R., 2011. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement. Sci. 6 (1), 42. https://doi.org/10.1186/1748-5908-6-42.

Moran, A.J., Khandpur, N., Polacsek, M., Thorndike, A.N., Franckle, R.L., Boulos, R., Sampson, S., Greene, J.C., Blue, D.G., Rimm, E.B., 2019. Make it fresh, for less! a supermarket meal bundling and electronic reminder intervention to promote healthy purchases among families with children. J. Nutr. Educ. Behav. 51 (4), 400–408. https://doi.org/10.1016/j.jneb.2019.01.012.

Piernas, C., Cook, B., Stevens, R., Stewart, C., Hollowell, J., Scarborough, P., Jebb, S.A., 2021. Estimating the effect of moving meat-free products to the meat aisle on sales of meat and meat-free products: a non-randomised controlled intervention study in a large UK supermarket chain. PLoS Med. 18 (7), e1003715. https://doi.org/10.1371/journal.pmed.1003715.

Röös, E., de Groote, A., Stephan, A., 2022. Meat tastes good, legumes are healthy and meat substitutes are still strange—The practice of protein consumption among swedish consumers. Appetite 174, 106002. https://doi.org/10.1016/j.appet.2022.106002.

SAPEA, 2020. A sustainable food systemfor the European Union. Berlin: SAPEA. https://doi.org/10.26356/sustainablefood.

SAPEA (mit Mathijs, E., Baird, J., Blomhoff, R., Büttner, A., Daugbjerg, C., Galli, F., Gwozdz, W., Janssen, M., Jehlička, P., Mattauch, L., Roosen, J., Röös, E., Schneider, T., Trichopoulou, A., Truninger, M., Van Doorn, J., & Vandevijvere, S., 2023. Towards sustainable food consumption: Evidence review report. Zenodo. https://doi.org/10.5281/ZENODO.8031939.

Schösler, H., Boer, J.D., Boersema, J.J., 2012. Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution. Appetite 58 (1), 39–47. https://doi.org/10.1016/j.appet.2011.09.009.

Schulze, M., Janssen, M., 2024. Self-determined or non-self-determined? Exploring consumer motivation for sustainable food choices. Sustain. Prod. Consumpt. 45, 57–66. https://doi.org/10.1016/j.spc.2023.12.028.

Sharpe, K.M., Staelin, R., 2010. Consumption effects of bundling: Consumer perceptions, firm actions, and public policy implications. J. Public Policy Mark. 29 (2), 170–188. https://doi.org/10.1509/jppm.29.2.170.

Stanovich, K.E., West, R.F., 2000. Individual differences in reasoning: Implications for the rationality debate? Behav. Brain Sci. 23 (5), 645–665. https://doi.org/10.1017/S0140525X00003435.

Stone, R.A., Christiansen, P., Johnstone, A.M., Brown, A., Douglas, F., Hardman, C.A., 2025. Understanding the barriers to purchasing healthier, more environmentally sustainable food for people living with obesity and varying experiences of food insecurity in the UK. Food Policy 131, 102798. https://doi.org/10.1016/j.foodpol.2025.102798.

Stremersch, S., Tellis, G.J., 2002. Strategic bundling of products and prices: a new synthesis for marketing. J. Mark. 66 (1), 55–72. https://doi.org/10.1509/jmkg.66.1.55.18455.

Tan, H.S.G., Fischer, A.R.H., van Trijp, H.C.M., Stieger, M., 2016. Tasty but nasty? Exploring the role of sensory-liking and food appropriateness in the willingness to eat unusual novel foods like insects. Food Qual. Prefer. 48, 293–302. https://doi.org/10.1016/j.foodqual.2015.11.001.

Thaler, R.H., Sunstein, C.R., 2008. Nudge: improving decisions about health, wealth, and happiness. Yale University Press.

Thaler, R.H., Sunstein, C.R., Balz, J.P., 2014. Choice architecture. SSRN Electron. J. https://doi.org/10.2139/ssrn.2536504.

Torheim, L.E., Fadnes, L.T., 2024. Legumes and pulses—A scoping review for Nordic Nutrition Recommendations 2023. Food Nutr. Res. 68. https://doi.org/10.29219/fnr.v68.10484.

Van Der Meer, M., Fischer, A.R.H., Onwezen, M.C., 2023. Same strategies – different categories: an explorative card-sort study of plant-based proteins comparing omnivores, flexitarians, vegetarians and vegans. Appetite 180, 106315. https://doi.org/10.1016/j.appet.2022.106315.

Van Der Meer, M., Schruff-Lim, E.M., Onwezen, M.C., Fischer, A.R.H., 2025. "Planting" meat substitutes in the meat shelf: an online and two supermarket field experiments to explore the effect of placing meat substitutes next to meat. J. Retail. Consum. Serv. 84, 104223. https://doi.org/10.1016/j.jretconser.2025.104223.

van der Vliet, N., Stuber, J.M., Raghoebar, S., Roordink, E., van der Swaluw, K., 2024. Nudging plant-based alternatives to meat and dairy in a real-life online supermarket: a randomized controlled trial. Appetite 196, 107278. https://doi.org/10.1016/j.appet.2024.107278.

Vogel, C., Dijkstra, C., Huitink, M., Dhuria, P., Poelman, M.P., Mackenbach, J.D., Crozier, S., Seidell, J., Baird, J., Ball, K., 2023. Real-life experiments in supermarkets

to encourage healthy dietary-related behaviours: Opportunities, challenges and lessons learned. Int. J. Behav. Nutr. Phys. Act. 20 (1), 73. https://doi.org/10.1186/s12966-023-01448-8.

Wertenbroch, K., 1998. Consumption self-control by rationing purchase quantities of virtue and vice. Mark. Sci. 17 (4), 317–337. https://doi.org/10.1287/mksc.17.4.317.

Whittall, B., Warwick, S.M., Jackson, M., Appleton, K.M., 2024. Barriers and facilitators to consuming pulses: a qualitative exploration including effects of trying recipes at home. J. Nutr. Sci. 13, e6. https://doi.org/10.1017/jns.2023.119.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L.J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J.A., De Vries, W., Majele Sibanda, L., Murray, C.J.L., 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. Lancet 393 (10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4.

Wolfswinkel, S.M.M., Raghoebar, S., Stuber, J.M., De Vet, E., Poelman, M.P., 2025. Can (Dynamic) social norms encourage plant-based food purchases? A quasi-experimental study in real-world Dutch supermarkets. BMC Med.. 23 (1), 150. https://doi.org/10.1186/s12916-025-03986-3.

Zühlsdorf, A., 2024. Hülsenfrüchte im deutschen LEH: Bewährte Klassiker oder Trendfood? Eine qualitative Marktübersicht im Rahmen des Forschungsprojektes StrahL. https://storage.e.jimdo.com/file/f1d80716-105b-4fee-a892-7f3a09edbba4/Marktstudie%20Hu%CC%88lsenfruchtangebot%20in%20Deutschland.pdf.

Zurek, M., Hebinck, A., Selomane, O., 2022. Climate change and the urgency to transform food systems. Science 376 (6600), 1416–1421. https://doi.org/10.1126/science.abo2364.