Environmentally sustainable food: an analysis of consumer practices and their diffusion in France

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Abstract:

- **Purpose** - This aim of this study was to identify ways of helping public authorities bring about change to environmentally sustainable household food practices. **Design/methodology/approach** - We identified the practices involved in this concept from the consumer perspective and measured their diffusion among French households. The analyses were conducted following two successive data collection campaigns comprising 571 and 501 respondents in France. The methodology involved two complementary scaling techniques: factor analysis and item response theory. **Findings** - The results show that consumers understand sustainable food through five food practices: buying and cooking products with sustainable attributes, anti-waste storage, self-production, plant protein consumption, and anti-waste cooking. **Originality**: The findings suggest that while at the individual level people appear to have incorporated anti-waste practices into their daily lives, at the household level there is still work to be done for improving diets and stimulating the production of home-grown food. It is also worth noting that that the emerging vision typically involves sustainable foods that are organic, locally grown, seasonal, based on fair trade, and packaging-free.

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Keywords: sustainable food; social practices; item response theory; consumer practices

1. Introduction

Food accounts for around one quarter of greenhouse gas (GHG) emissions on the scale of a country like France (Ademe, 2016; Barbier et al., 2019), a volume which is almost equivalent to housing (26%) or transport (25%) contributions. As such, it is a major area of concern in climate change mitigation. For example, the Institute for Climate Economics (I4CE) estimates that emissions from food demand represent 28% of global emissions from all sectors combined (Rogissart et al., 2019). While this proportion may vary from one country to another, studies converge to emphasise the need for household food patterns to change in the coming decades (Lazzarini et al., 2018). France has committed to reducing its emissions by 40% by 2030 and achieving carbon neutrality by 2050, a pledge which implies action on the food front.

The present study is based on the above-mentioned objectives, and examines the ways in which the scientific community can help public authorities and economic actors bring about change to household behaviours in this area (Shultz et al., 2022). And from this perspective, the environmental issues of food form the core of our study. The United Nations Food and Agriculture Organization (FAO) defines a sustainable diet as one "*with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations*" (FAO, 2010). Sustainable Food is a relatively recent concept and it is based on a holistic and integrated view of the societal challenges of food choices (Reisch et al., 2013; van Bussel et al., 2022). Many social, economic and environmental issues are detailed in the EAT-*Lancet* Commission report (Willett et al., 2019). It is important to note that our study retains the consumer perspective and focuses on the environmental aspects of food choices in order to reflect, through a non-exhaustive and non-expert approach, how consumers address these issues in their daily actions. To define the scope, we adopt the notion of Environmentally Sustainable Food (ESF). While this topic is frequently studied, the literature generally focuses on specific

behaviours, such as how to minimise food waste, to consume organic, fair trade, and locally grown products, and to adopt a more plant-based diet (Ruiz Molina et al., 2022). However, few studies holistically examine food habits and choices to identify the necessary actions for reducing the environmental impact of this component of our lifestyles (Niva et al., 2014, Notarnicola et al., 2017). As a result, there seems to be a gap between the circumscribed study objects of academic works and the sectoral approach favoured by public decision-makers. Moreover, the few studies that use a wide spectrum are based on expert insights and methods, such as life cycle analysis (LCA) and make recommendations and proposals based on objective criteria. However, these studies do not reflect how individuals understand this topic and approach it in their daily lives, but for public actions to be efficient, decision-makers need to be aware of, from a comparative viewpoint, the environmentally friendly behaviours that consumers have already adopted and those that are less widely diffused. Despite the potential theoretical interest and managerial impacts in this area, there is a gap in the literature for comprehensive, user-based and broad-ranging studies of household behaviours that would contribute to minimising the environmental impact of food production and consumption.

Therefore, our study adopts this all-round approach and sets out to meet two objectives: (1) to identify what is meant by environmentally sustainable food (ESF) and, more precisely, the consumer practices included in this concept, and (2) to measure the diffusion of these environmentally sustainable food practices among French households.

From a methodological perspective, these objectives require a measurement scale that is appropriate for an ESF concept based on an analysis of individual statements. This is a classic approach in the consumer behaviour field that first involves the definition of the concept, followed by an exploratory stage, and finally a confirmatory stage with two distinct samples (Churchill, 1979). As such, the present study follows this procedure and uses a conceptual framework based on the notion of practices, as defined in the theory of social practices (Shove

et al., 2012). Section 2 defines the scope of the ESF concept, and focuses on the different actions and applications covered. And section 3 presents the methodology used for the creation and validation of the ESF measurement scale. The analyses were based on two successive data collections in France: 571 respondents and 501 respondents. The approach involved two complementary scale construction techniques: factor analysis and item response theory (IRT). The results obtained (Sections 4 and 5) allowed us to identify five components of ESF practices and then evaluate their respective diffusion among the French population. Finally, the results, their implications, and their potential for future research will be discussed. The methodological choices made during the course of the study were also informative in the measurement of these practices (sections 6 and 7).

2. Literature Review

2.1 The Scope of Environmentally Sustainable Food from a Consumer Perspective

Studying ESF necessarily involves the consideration of consumption behaviours that are generally viewed as having a low(er) environmental impact. Therefore, the present study takes a comprehensive but broad approach towards consumers' daily actions that are recognized (in whole or in part) for their ecological benefits. The specific impacts (water, biodiversity, greenhouse gas emissions, etc.) of each behaviour will not be discussed here as they are beyond the scope of this paper. The present study initially focused on defining "ESF" behaviours, which required all of the food's life stages to be included, from farm to fork (König and Araújo-Soares, 2021). In this respect, the literature review highlights innumerable studies focusing on more limited behaviours, with the themes of food waste and organic food being frequently studied. To facilitate and guide this operational definition of ESF, we retained a categorisation

of daily food practices based on the chronology of consumer acts (Dyen et al. 2018): (1) sourcing, (2) choosing products, (3) cooking and related household practices (storage, fridge organisation, etc). Taking into account these stages and based on a detailed analysis of 195 scientific and managerial publications (available in the supplementary material section), we were able to identify the main ESF-related consumer behaviours.

Table 1 presents a summary of this first step. Behaviours outside the domestic sphere, such as eating out or purchasing take-away food, are beyond the study scope as they have their own specific issues and challenges that are different from those of home cooking (Chen et al., 2017).

Table 1:

As shown in table 1, an analysis of ESF from a consumer perspective covers multiple activities that may or may not be market-oriented. Defining the scope of the ESF adopted here is based on a literature review and uses a provisional categorisation according to three consumer activities. We aim to extend the research by exploring how consumers approach these issues in reality in order to try and determine how behaviours are actually grouped together in the daily habits of households. Based on consumer associations rather than a theoretical, or technical, categorisation, the key innovation here is that diffusion drivers can be analysed and adapted to each identified component.

2.2 Practice Theory framework

The most appropriate conceptual framework for examining ESF from a consumer perspective appears to be practice theory, which originally developed in the field of sociology in the United Kingdom and Scandinavian countries in the 2000s (Sirieix and Le Borgne, 2017, White et al., 2022). This framework inverses the most typically adopted perspective by starting with the

practice rather than the individual hypothesis, thus focusing on practice and practice carriers rather than the individual. Reckwitz (2002) defines a practice as "*a routinized type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge*" (Reckwitz, 2002: 249). This means that a practice may be identified by three main component types: competence, materials, and meaning (Shove et al., 2012). Additionally, a practice can also be seen in terms of how it is embodied in real life: in other words, through the many everyday actions of the "carriers" who perform this practice (Schatzki, 1996).

This displacement of the observed entity provides a new perspective for understanding how practices spread among consumers. In particular, it is through the repetition of their "performances" that practices evolve over time (Shove et al., 2015; Shove et al., 2007; Warde, 2005). A practice spreads by "recruiting" new individuals who will, over time, make it part of their daily routine (Dubuisson-Quellier and Plessz, 2013). Take the example by Shove et al. (2012) who studied driving. At the very beginnings of driving, circa 1900, representations were mainly of pioneers, and car ownership quickly became the reserve of more affluent people who lacked skills and were able to use drivers. As driving gradually became less technical, the practice became more widespread, making the diffusion of driving in Western societies the result of increasingly accessible skills, positive representations, and public facilities and infrastructures. The spread of new practices can be observed by identifying their components and how they interact. It is also useful to determine the actions under which the practice is performed (Shove et al., 2012), which in turn makes it possible to monitor the frequency (or diffusion) of these actions within the population. Studies on components of ESF practices (Innocent et al., 2021), or how they interact together (Klitkou et al., 2022), already exist in the literature, but there are very few on the diffusion of this set of practices.

To try and fill this gap, the present study will first establish a set of actions that best reflects the diversity and complexity of ESF practices. These measures will then be used to observe the diffusion of this practice within the French population.

3. Methodology

The study was divided into two stages: (1) creation of a measuring scale for the frequency of ESF practices (Section 3.1), and (2) measurement of the diffusion of ESF practices within households in France (Section 3.2). The study design is similar to a mixed method as it combines qualitative secondary data type from the literature and quantitative data type from the two surveys (Johnson et al.,2007).

The two data collections were carried out using Computer Assisted Self-Interviewing (CASI) to minimise the social desirability response bias (de Peretti, G., & Razafindranovona, 2014). The first collection was conducted using a convenience sample (n_1=571), mainly in western France during spring 2019, and the second in Metropolitan France at the end of January 2020 (n_2=501)[1], using a representative sample of the French population based on the quota method (gender, age, socio-professional category and level of education) and with a controlled distribution of the respondents' geographical location. Additionally, household composition and income were collected. The data were checked and cleaned[2] before analysis. The characteristics of these two samples are presented in Table 2 and compared, for the quota

[1] The sample size was determined by balancing statistical accuracy, the project's budgetary constraints, and common survey practices (Lapin, 1993). It is in line with current standards (Hartmann et al., 2018).

[2] We collected 582 questionnaires for study 1 and discarded 9 outliers, and 577 questionnaires for study 2, of which 76 were discarded because they did not meet the quality conditions we had set (a response time equal to or greater than the eight minutes considered essential for a correct response, and an absence of a repetitive series of responses to the item scales).

sample, with the distribution of these socio-demographic indicators in the population of metropolitan France.

The methodologies used in these two stages are described in the following sections.

Table 2

3.1 Study 1: Identifying Sustainable Food Practices and Building a Tool to Measure their Frequency

The first step was to create a scale with good validity and reliability indicators (Hair et al., 2018). The methodology applied in this study was divided into five steps.

Building the measurement tool involved various steps, and followed the process recommended by Churchill (1979), which starts with the generation of items describing ESF practices based on the literature review (step 1). In practical terms, the approach consisted of generating a list of reflexive measurement items for the practices identified in the literature (Table 1). Seventy-one items were subsequently created and then submitted to five academic and industry experts (management sciences and a green transition agency, respectively) who assessed the relevance and validity of the items in relation to the subject matter. This led to the elimination of thirteen items. The remaining 58 items covered sourcing (shopping or self-producing food) (21 items), product choice (13 items), and household habits (cooking and related household practices – e.g., storage and fridge organisation) (24 items).

Following data collection (step 2), exploratory analyses were conducted to identify the dimensions (step 3). Principal Component Analysis (PCA), which is based on a matrix of correlations between variables, is the method that is generally used to identify data (Hair et al.,

2018). However, the results obtained are partly unstable in the sense that changing a parameter (type of rotation, removal of an item, etc.) could lead to the disappearance of certain dimensions from the solution obtained.

This instability in factor structure can be explained by the formation of difficulty factors (Ferguson, 1941; Hardouin, 2005). In the ESF field, individuals wishing to adopt environmentally-friendly practices sometimes come up against constraints that hinder their actions (Kaiser and Wilson, 2004). For example, buying organic meat is less widespread than buying organic fruit and/or vegetables, but both types of purchase are certainly related. PCA will potentially fail to aggregate the two behaviours despite the existence of clear links between them because of an unsystematic correlation among individuals.

Item response theory (IRT) allows us to consider this reality by classifying and purifying items according to their degree of difficulty as experienced by consumers (Kaiser and Wilson, 2000). In classical test theory, there is a linear relationship between indicators and latent variables. However, this is not necessarily the case in the IRT and the probability of obtaining a certain type of response depends on several parameters which can be related to items or to respondents – such as their abilities and, by extension, their competence in a specific domain (Demeuse, 2008; Pras et al. 2009). IRT is rarely used in management sciences despite its potential (Raykov and Calantone, 2014). Therefore, we tested the IRT measure using the Mokken method (step 3) for all items (Rusch et al., 2017; Van der Ark, 2012). A comparison of both methods (step 4) shows that they must be used in combination as neither is sufficient to cover all ESF practices and dimensions alone: for PCA, this is because some dimensions are unstable, and for IRT it is because items with increasing levels of difficulty are required

Following confirmatory analyses (step 4), the measurement solution selected here was based on a combination of these two methods (step 5): PCA for four dimensions and IRT for

one (using the Partial Credit Model). The validity tests of the five dimensions met the required standards. Finally, a full test of the model with all five dimensions was performed using partial least squares (PLS) structural equations (step 5). This indicates a good fit of the data to the solution presented herein (SRMR = 0.08).

Finally, the measurement tool consisted of 28 items grouped into five dimensions. The response modalities range from 1 to 5 and, depending on the items, correspond to measures of subjective frequency (from *never* to *systematically*) or objective frequency (number of times per day or per week, depending on the product).

3.2 Study 2: Measuring the Diffusion of ESF Practices in Households in France

A second data-collection campaign was conducted to measure the diffusion of ESF practices among the French population. This involved applying the measurement scale created from step 1 of the study to a representative sample of the French population. The quota method was applied using the following five socio-demographic criteria: age, gender, social category, level of education, and place of residence.

After checking the stability of the five-dimensional measurement scale on the second sample (step 2), the scores were calculated for each individual on a scale ranging from 0 to 100 for the five dimensions (step 3). This step was carried out using partial least squares structural equation modelling, which provided an overall view of a respondent's profile while standardising the scores of the dimensions derived from the IRT and factorial methods. Finally, the means and other descriptive statistical indicators of individual scores were calculated by item and dimension for the entire sample. In addition, and as has already been done by some authors studying local food (Bryla, 2019), we sought to bring out possible socio-demographic

determinants by carrying out ANOVAs with the age, gender, social category and income variables.

Table 3 summarises the steps of the second study.

Table 3

4. Results of Study 1: Identifying practices associated with environmentally sustainable food

The final measure of ESF-associated practices consists of a broad-scope component fitting an IRT model (16 items) along with four factors that reflect more specific aspects (12 items).

4.1 The D1 Dimension

The first dimension, labelled D1, groups together everyday actions associated with *buying and cooking sustainable products*. It includes some domestic practices, such as the use of energy-efficient cooking methods, and the reuse of certain food packaging (glass jars, bottles, etc.). In the framework of this scale model, items can be classified according to their degree of difficulty for individuals.

Construction of an IRT scale makes it possible to assign a parameter to each respondent that corresponds to their latent trait score. In addition, we can define an average parameter (called *location*) for each item, which also places it on the latent trait scale.

Figure 1 shows the distribution of the items in the dimensions. The higher the item on the graph, the more widespread the action in the population. The four threshold values (1–4) for each item

correspond to the four response modalities other than *never*. The higher the threshold value, the higher the position of the latent trait. The black dots correspond to the location parameter of the item for the latent trait.

Figure 1

In the framework of IRT models, reliability of the scale is ensured by the parameters of the items and by the value of the separation reliability indicator (SepRep), which varies between 0 (zero reliability) and 1 (perfect reliability). A value > 0.70 indicates adequate reliability (Petrillo et al, 2015, Andrich, 1982).

In our case, the indicator is 0.91, indicating very good reliability.

4.2 Dimensions D2, D3, D4 and D5

The four other dimensions of ESF practices obtained by PCA were *anti-waste storage* (D2), *self-production of food* (D3), *plant protein consumption* (D4), and *anti-waste cooking* (D5).

These four measurement dimensions showed satisfactory reliability, with loadings of their measured variables strictly above 0.6 and mostly between 0.7 and 0.85. The Cronbach's alpha values were also above 0.60.

4.3 Measurement quality in five dimensions

A confirmatory factorial analysis was carried out using PLS-PM to validate the quality of dimensions D2 to D5 (the variables are all unidimensional, and their Dillon-Goldstein Rho, an indicator of the reliability of the measurement that is insensitive to the number of items, is greater than 0.8). The analysis also demonstrated the discriminant validity of the measurement tools (the Average Variance Extracted was greater than 0.5).

Analysis of the correlations between the five measures shows that the dimension D1 (*buying and cooking sustainable products*) is correlated with the four other practices, and more particularly with D4 (*plant protein consumption*). The two dimensions of anti-waste practices (storage and cooking) are also correlated.

5. Results of Study 2: Measuring the diffusion of ESF practices in France

5.1 Checking the Reliability of the Scale

The second part of the study began by verifying the reliability of the measurement on a representative sample of the French population. The results indicate that the measurement tools were reliable (Table 4).

For the *buying and cooking sustainable products* dimension (D1), we noted some changes in the order of item difficulty. More precisely, the items reflecting entry actions in the ESF practices remained the same and were ordered very similarly between the two data collections. Although the purchase of organic fruit and vegetables appears to form part of the "basics" of ESF practices for the first sample, we note that it is in the middle of the scale when the sample is more representative of the diversity of the French population. The statistical reliability of the tool was maintained, as indicated by the quality of the SepRep indicator, equal to 0.90, and which is assimilable to a Cronbach's alpha (Petrillo et al., 2015).

For the dimensions *anti-waste storage* (D2) and *self-production of food* (D3), the reliability indicator (Cronbach's alpha) was greater than or equal to 0.70 for both factors and was therefore satisfactory. For *plant protein consumption* (D4) and *anti-waste cooking* (D5), the indicator value was below 0.6. However, for all four factors, the Goldstein Rho (D-G) was above 0.70, indicating good reliability of the factors.

All correlations between the latent variables were significant (Table 4), except for the correlation between *anti-waste storage* (D2) and *self-production of food* (D3).

Table 4

We then analysed the overall and detailed diffusion of the five practices.

5.2 Diffusion of Five Sustainable Food Practices Among the French Population

After checking the reliability of the measurement tools, it was possible to calculate the factor scores for dimensions *anti-waste storage* (D2) to *anti-waste cooking* (D5), and the score of the average responses to the items for the dimension *buying and cooking sustainable products* (D1). The scores were standardised and presented on a scale of 0–100. Figure 2 presents the descriptive statistics for the average standardised scores.

Figure 2

Practices related to anti-waste measures are the least scattered. In other words, the spread of anti-waste, storage, and meal preparation actions is fairly homogeneous among the population. Behaviours related to product choice (D1) are more widely dispersed. This observation is related to how this component is constructed. The average score for *buying and cooking sustainable products* (D1) is 50 out of 100 as the model is designed to obtain a variable with these mathematical properties.

Components related to the consumption of plant proteins were scattered, indicating contrasting behaviours in this area.

Finally, regarding *growing your own food*, 50% of the population scored below 35/100, reflecting the low diffusion of this practice.

The *buying and cooking sustainable products* dimension seems to follow a normal distribution, whereas the other four dimensions do not show a symmetrical distribution of their mean values. Studying the frequencies of actions measured within each practice made it possible to clarify this observation.

5.3 Frequency of Actions Reflecting the Different Practices Associated with ESF

Figure 3 shows the frequency of each practice and the different actions that make it up. The dimensions and items were arranged in descending order of diffusion; in other words, the most widespread practices are shown at the top of the figure, and the least frequent at the bottom.

Figure 3

Anti-waste practices (D2 and D5) are much more widespread among the French population than most of the other measured behaviours. Over 75% of the population often or systematically adopts stocking up and storage measures to avoid food waste. Measures to avoid waste at the meal preparation stage are also widespread, such as freezing or using leftovers (respectively, 80% and 74% of individuals do so often or systematically).

In some cases, the actions corresponding to the practice of *buying and cooking sustainable products* (D1) were closely related to the degree of diffusion of anti-waste practices. This is the case for cooking at home, buying local fruits and vegetables, and reusing food packaging. There is a partial correlation between limiting the amount of packaging when buying food and

buying products from the deli counter "by the slice" (named "*produits a la coupe*" in the questionnaire in the French context); these two types of actions show a medium level of diffusion. Approximately 50% of our sample carried out such actions often or systematically, and the other 50% did so from time to time or never. A minority of individuals carried out the actions of purchasing organic or labelled products and buying from local producers systematically or frequently.

Thus, only part of the population is concerned with growing its own food of fruits and vegetables, or consumes such produce with friends and family: about 40% of respondents never take part in such practices.

Finally, we note that the consumption of processed products containing plant-based proteins is no longer an exception; it is a common practice for 25% of respondents and an occasional practice for 25%. The percentage of individuals who had never consumed such products was less than 10%. On the other hand, regular consumption of pulses remains in the minority.

Finally, we used an ANOVA test to see if there was a difference in the diffusion of the different ESF practices between gender, age group, social category (SC) and income level (the distribution of which was not representative as there were less higher income respondents in the sample than in the population). The results show that there is virtually no effect of gender on these practices. Men have a significantly higher declared frequency of the practice D1 – *buying and cooking sustainable products* – than women (R2=1%; F=3.94; *pv*=0.048), but this must be moderated by the fact that they also do far less shopping than women in France (Roy, 2012). On the other hand, SC and income shows a more convincing effect on the practice D1 – *buying and cooking sustainable products* (SC: R^2=7%; F=7.19; *pv* <0.0001 / Income: R^2=6%; F=11.33; *pv*<0.0001). In both cases, the higher the income or SC (senior manager, independent professionals, self-employed people, etc.), the more intense the practice. Lastly, practices are not significantly dependent on age, with the one exception being plant protein consumption

(D4) (R^2=3%; F=3.87; *pv*=0.004), which is higher in the 15 to 44 age group than in the 45 and over age group.

6. Discussion

6.1 Different Dimensions of ESF Practice from a Consumer Perspective

The specific aim of this study was to adopt a global vision of food behaviours with a lower environmental impact. The two data collections presented here lead to the categorisation of these behaviours from a consumer's point of view. It is interesting to note that this differs from the theoretical approach adopted at the outset of our research, which was based on three chronological stages: sourcing, choosing and cooking products in daily life (Dyen et al., 2018). For example, waste is salient according to whether the action refers to cooking (D5) or storing (D2), probably because such practices correspond to different moments and/or know-how. Conversely, buying local and organic food in bulk, as well as sustainable fishing and the procurement of fair trade or low-packaging products, are grouped together in the same set (D1 *buying and cooking sustainable products*), which means that the consumer associates products with environmental attributes. Food labels, local origin, and less packaging are the main signals indicating the environmental quality of a food. Interestingly, the issue of diet also appeared in another dimension (D4 *plant protein consumption*). This includes the choice of plant proteins or pulses but does not cover reductions in the consumption of meat and other animal-based food products. Items dealing with these aspects were introduced into the measure but were excluded from the statistical analyses. Finally, growing your own fruit and vegetables (D3 *self-production of food*) emerges as another possible way of adopting ESF, and is distinguished from *plant protein consumption* by its non-market aspect. Finally, the measure mixes market

and non-market behaviours and reflects how consumers approach ESF practices. These findings provide lessons for public policy (Section 7).

6.2 ESF Diffusion in France

ESF diffusion can be analysed at two levels: within a single component and, more generally, by comparing the respective diffusions of the different components. It is important to note that because the *buying and cooking sustainable products* (D1) component was constructed differently (IRT method setting the average score of the sample at 50/100), it cannot be compared with the other components (D2 to D5) in terms of diffusion.

Regarding *buying and cooking sustainable products* (D1), the IRT measure allowed us to classify the 16 items included in this dimension according to their degree of accessibility. Cooking at home is the most widespread and therefore the easiest practice for French consumers[3]. The purchase of organic fruits and vegetables comes close to this first level of diffusion, however, shopping for groceries or meat from local producers is not a widespread practice. This finding corroborates the results which show that the diffusion of buying and cooking practices are linked to material environment issues (Innocent et al, 2021). Indeed, organic food is now more easily accessible, and 90% of consumers in France are occasional or regular consumers, representing a market that is worth €13 billion (Agence Bio, 2021). We find that this practice is facilitated by increasing availability in supermarkets, as many consumers do not have access to producers selling directly in their vicinity. Likewise, buying from the deli counter and limiting packaging are at an intermediate level of difficulty, whereas buying in bulk, excluding fruits and vegetables, remains complicated. Once again, these results

[3] Home consumption, including meal delivery, is still the most common method of consumption in France. In 2018, only 14% of French people's meals were eaten outside the home and only 6% of breakfasts (FranceAgriMer, 2018).

can be compared with the less widespread diffusion of bulk products in France (40% of households, €1.3 billion turnover) (Réseau Vrac, 2021).

Our study revealed four other practices associated with ESF consumption, two of which are widespread in France: the anti-waste practices of storage and cooking. These behaviours are widely adopted by the population and are on a par with home cooking, buying local fruits and vegetables, and reusing food packaging. The most likely explanation is that these practices are associated with meanings that go beyond ecology, such as money saving or good household management (Stefan et al., 2013). Moreover, the social norms attached to these behaviours are strong and support intergenerational transmission within households (Moore et al., 2002).

Self-production of food (D3) and *plant protein consumption* (D4) are much less common. The first is conditioned by specific skills and knowledge as well as access to a garden. The low uptake of the second practice could be linked to habits and the social image of meat consumption (Dagevos and Voordouw, 2013; Hwang et al., 2020). Results show that younger people are more likely to opt for plant-based proteins. The adoption of a plant-based protein diet comes up against certain representations of what a balanced and gastronomic meal should be (Cartron and Fichet, 2020) in French cuisine and in other Mediterranean cultures. This has recently been seen in Portugal in the context of collective catering (Graça and al., 2022), and it is likely that these representations are stronger among older people.

6.3 Limitations and Lessons Learned on the Measurement of Practices

The findings of this study are the result of the rigorous methodological process detailed in Section 3. However, there some limitations to the resulting measurement scale that are instructive for future research.

The first limitation is the approach we adopted, which is based on the associations respondents make between everyday practices. Behaviours initially identified as part of the concept were eliminated from the measurement tool if they were not associated with any other items. Thus, three important aspects of sustainable food, although initially included, were excluded from our measurement tools during the statistical processing: sorting packaging, composting organic waste, and reducing the consumption of meat products. This suggests that these practices are currently not associated with other sustainable food practices. There are several possible explanations for this observation. Sorting is a behaviour that most people have integrated into their everyday life and is therefore not specifically associated with sustainable food. For composting, the measurement of this behaviour has a statistical distribution similar to that of a binary variable: individuals either carry out composting or they do not, which may explain the lack of correlation with other practices. Finally, the decrease in meat consumption was surprisingly not reflected in the measured diffusion of ESF practices. This indicates that people may reduce their meat consumption for purposes other than environmental conservation, such as better health, animal welfare considerations, or economic reasons. Adopting a plant-based diet clashes with representations of a balanced and gastronomic meal in French cooking (Cartron and Fichet, 2020).

A second limitation of the measurement tool is the difficulty of rigorously comparing the five components of sustainable food. The factor analysis method was used for four dimensions (D2 to D5), while the measure of *buying and cooking sustainable products* (D1) was based on the IRT method, using items of increasing difficulty. The IRT methodology was adopted in this study to solve problems encountered during scale construction. As a result, IRT seems to offer a better representation of consumers' experiences; that is, the existence of behaviours that are widely accessible compared to other behaviours that are more demanding and restricted in their diffusion. In other words, this methodology allowed us to identify the levels of difficulty in the

behaviours required by individuals to achieve food transition objectives. Thus, it is more realistic to distinguish between individuals according to their level of commitment to ESF than according to the topics they are committed to. This observation is in line with recent typologies of responsible purchasing behaviour outside the food sector (Durif et al., 2011; Picha and Navratil, 2019). To construct a future measure of sustainable food practices, we recommend using the IRT method, that is, including behaviours of varying difficulty for each component. For example, for the *self-production of food* component (D3), we could include more measures related to the products we process ourselves, such as making our own bread, yoghurt, and other milk-based products. This method requires a large number of items which makes data collection cumbersome and costly. Furthermore, the models associated with IRT can only work if the measure includes progressive behaviours from an individual's point of view. The only way this can work is by opting for a precise and therefore detailed measurement of one of the ESF components rather than the whole set. Moreover, such a measure is necessarily evolutionary and should be updated regularly to monitor the level of adoption of a given behaviour by individuals. For example, it is possible that moderation of meat or insect consumption will be included in the measurement of ESF practices in the future. This approach can also be adapted to other cultural contexts since there is no such thing as sustainable food per se, but rather sustainable food for different populations and communities. Finally, it should be noted that an IRT measurement can also potentially be applied to other ecological transition topics such as digital and transport, or energy consumption which it has already been used for in a few studies (Thøgersen and Grønhøj, 2010).

7. Implications for stakeholders and conclusion

These results lead to several recommendations for public authorities and food professionals.

First, it should be noted that in terms of its representation, the notion of ESF is not yet well understood. For the general public, ESF mainly translates into actions related to provisioning, and does not include the whole range of domestic practices that may be associated with it. An interesting observation that emerges from our study is the vision of a typically sustainable dish: home-made with organic, local, seasonal, fair trade and unpackaged products. The consumer appears to place these different characteristics at the same level, which reinforces the need for a global approach to ESF rather than a market approach. An organic food can be an alternative to an unpackaged or seasonal product, and vice versa. Practice theory indicates that underlying meanings are identical and likely to be related to both green and healthy eating. This can be an argument for bringing together in stores all products with an environmental advantage instead of dividing them into different stores or store shelves. This also suggests a probable confusion from consumers when a food product is good on one criterion but bad on another, for example, the choice between a packaged organic fruit and a local non-organic fruit with no packaging. As results show, consumers probably value the naturalness and traceability of a food more than its precise environmental characteristics. This has practical implications for implementing better positioning of ESF offers. Another interesting observation is the absence of meat consumption in the representation of ESF in the minds of the public. To go beyond French culinary traditions, great efforts need to be made as regards awareness-raising and education on the subject of meat consumption. Therefore, the environmental issues related to reducing meat consumption should be made more widely known. In comparison with other subjects such as organic farming and local purchasing, this issue has recently appeared in the public debate in France. For example, a law has just been passed on this subject ("Climate and Resilience" law, August 41, 2021, Article 59), which has required canteens in the education sector to offer a vegetarian menu once a week since 2023. We can imagine that initiatives led by NGOs such

as Green Monday will also help cause a shift in our knowledge and representations of this subject.

Another contribution of this study is the creation of an operational and reliable tool for measuring ESF practices. This tool provides an indicator of ESF diffusion within a population, and allows us to monitor its progress. More precisely, our research shows which subjects should be prioritised. While anti-waste actions seem to be well-known to individuals, changes in diet and self-production do not yet concern the majority of the population. As postulated by the theory of practice, ESF diffusion requires a focus on the links between knowledge, the material environment, and collective meanings on the subject. Therefore, efforts need to be made to popularise the environmental issues associated with these practices. This recommendation should also be seen in light of the real impact of greening the food supply. Reduction in meat consumption has been increasingly identified as the main lever for reducing food-related greenhouse gas emissions. Therefore, public authorities wishing to promote ESF should also emphasise this issue by proposing solutions that are culturally acceptable in France, such as serving smaller portions, or alternating meat-based and meat-free meals.

In conclusion, this research opens the door to future studies such as the repeated measurement of ESF practices not only among the French population, but also among populations from other countries. More studies adopting a holistic view of sustainable food also seem necessary if all its dimensions (social, cultural and economic) are to be embraced.

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Tables

Table 1: The scope of environmentally sustainable food based on consumer practices

Category	Behaviours	Examples of references
Sourcing	-Buying from local producers' shops or directly from organic shops or markets -Buying in bulk, using your own containers (jars, boxes) and bags, etc. -Avoiding waste at the time of shopping: paying attention to expiry dates, menu lists, etc. -Using soft means of transport, coupling with other trips -Producing your own food or that of others (vegetable garden)	Hughner et al (2007); Aschemann-Witzel et al. (2018); Vicart and Wathelet (2016); Van de Walle (2013).
Choosing products	-Buying organic, fair trade, sustainable fishing products -Buying and adapting your meals to local products -Buying and adapting your meals to seasonal products -Choosing products with limited packaging	Pernin and Carimentrand, (2012); Peterson et al. (2015); Merle and Piotrowski (2012); Williams et al. (2012).
Cooking for everyday life	-Eating a diet based on fruit, vegetables, pulses, and reducing processed products, meat, etc. -Avoiding waste when storing and putting away food -Home cooking, cooking with leftovers, cooking in an energy-saving way (lid, oven inertia, ...) -Sorting and recycling packaging, composting organic waste, reusing packaging	WWF (2017); Monot et al (2014); Innocent and François-Lecompte (2018); Dumain and Rocher (2017).

Table 2 - Socio-demographic description of the two samples

Frequency in %		Sample study 1 (n_1=571)	Sample study 2 (n_2=501)	French population[a]
Gender	Men	**39**	**46**	48
	Women	**61**	**54**	52
Age	15-29	**23**	**19**	22
	30-44	**26**	**26**	24
	45-59	**28**	**26**	24
	60 and over	**23**	**30**	30
Level of education	Higher education diploma	**68**	**28**	28
	Bachelor's degree	**18**	**25***	17
	Vocational degree	**9**	**24**	24
	No diploma	**5**	**22***	31
Socio-professional categories	Self-employed person	**4**	**3**	4
	Senior manager, independent professionals	**24**	**8**	9
	Middle-level occupations	**8**	**10***	14
	Employee or Worker	**25**	**31**	29
	Retiree	**21**	**25**	27
	Other: inactive persons	**18**	**23***	16

Location	Paris Region	**12**	**16**	19
	North	**4**	**10***	6
	East	**6**	**7**	8
	East Paris area	**4**	**8**	8
	Western Paris area	**6**	**8**	9
	West	**47**	**14**	14
	South West	**8**	**12**	11
	Central East	**7**	**12**	12
	Mediterranean	**5**	**12**	13
Family situation	Couple with child(ren)	**32**	**39**	26
	Single with children	**6**	**8**	10
	In a child-free couple	**33**	**29**	26
	Single and child-free	**22**	**19**	35
	Other case	**7**	**5**	3
Household size	1 person	**21**	**19**	35
	2 people	**38**	**36**	33
	3 people	**18**	**19**	14
	4 or more	**23**	**27**	18
Income	Under €21,120	**33**	**38**	30
	From €21,120 to € 41,290	**39**	**41**	40

	Over €41,290	**27**	**16**	30
	No answer	**11**	**6**	

a *Source: the French National Institute of Statistics and Economic Studies (INSEE), 2015 or 2013 statistical series, depending on availability.*

** Difference in proportion significant at the 0.05% threshold.*

Table 3 - Steps in measuring the diffusion of ESF practices - Study 2

Steps	Work carried out	
1 -Second data collection	- 501 respondents representative of the French population	
2- Checking the validity of the measurement tool	PCA method (4 dimensions, 12 items) - confirmatory factor analysis in PLS - Cronbach's alpha measure and Dillon-Goldstein's Rho	IRT method (1 dimension, 16 items) - confirmatory analysis in PCM (Partial Credit Model) - measurement of the separation coefficient
	Calculation of correlation coefficients between dimensions	
- Measuring the diffusion of ESF practices	- Calculation of standardised scores per item and per dimension (by PLS structural equation model) - Descriptive statistics	

Table 4. Reliability indicators for the five dimensions and their correlation in the second data collection

Scales		Reliability SepRep / Cronbach's α	D-G rho	Correlation of the five components of ESF				
D1	Buying and cooking sustainable products	SepRep: 0.90		1				
D2	Anti-waste storage	Cronbach's α: .77	.81	.29	1			
D3	Self-production of food	Cronbach's α: .70	.89	.28	ns*	1		
D4	Plant protein consumption	Cronbach's α: .62	.79	.43	.13	.14	1	
D5	Anti-waste cooking	Cronbach's α: .63	.78	.24	.25	.19	.21	1

*"ns" indicates not significant

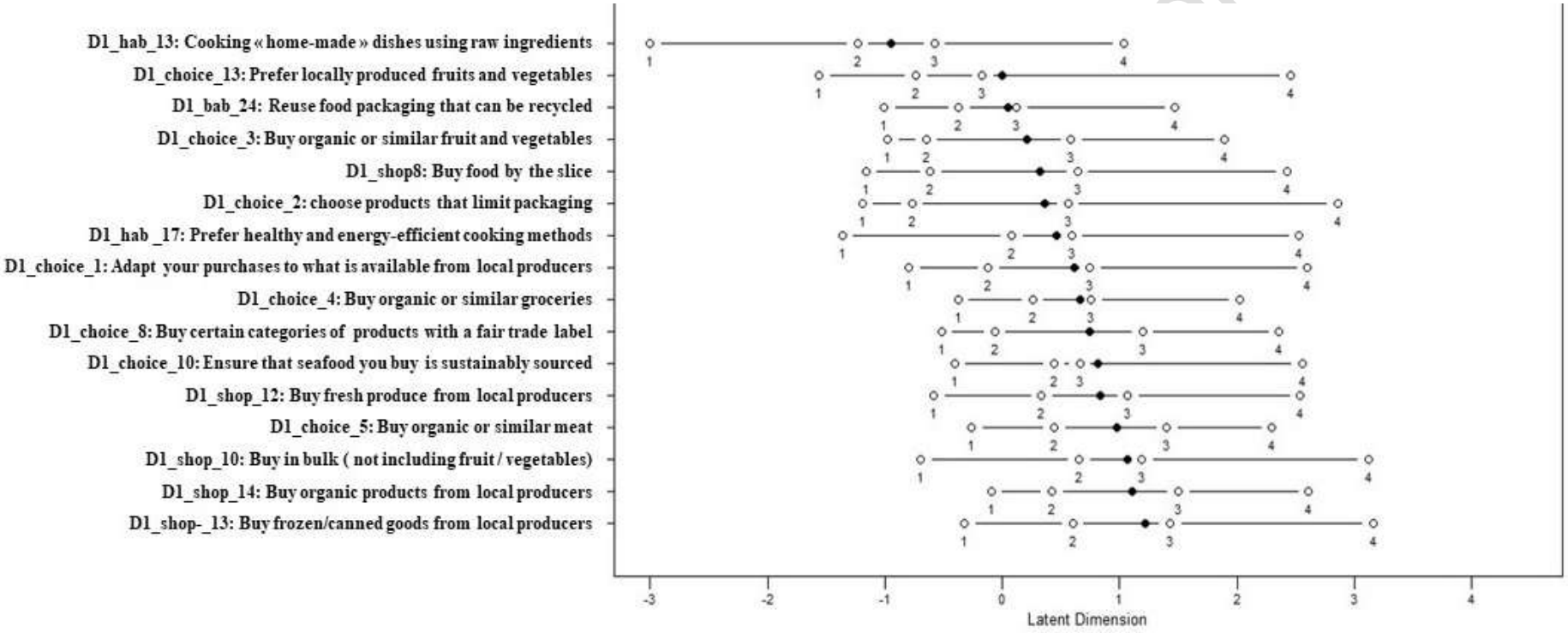

Figure 1 - Person-items Map of the D1 scale

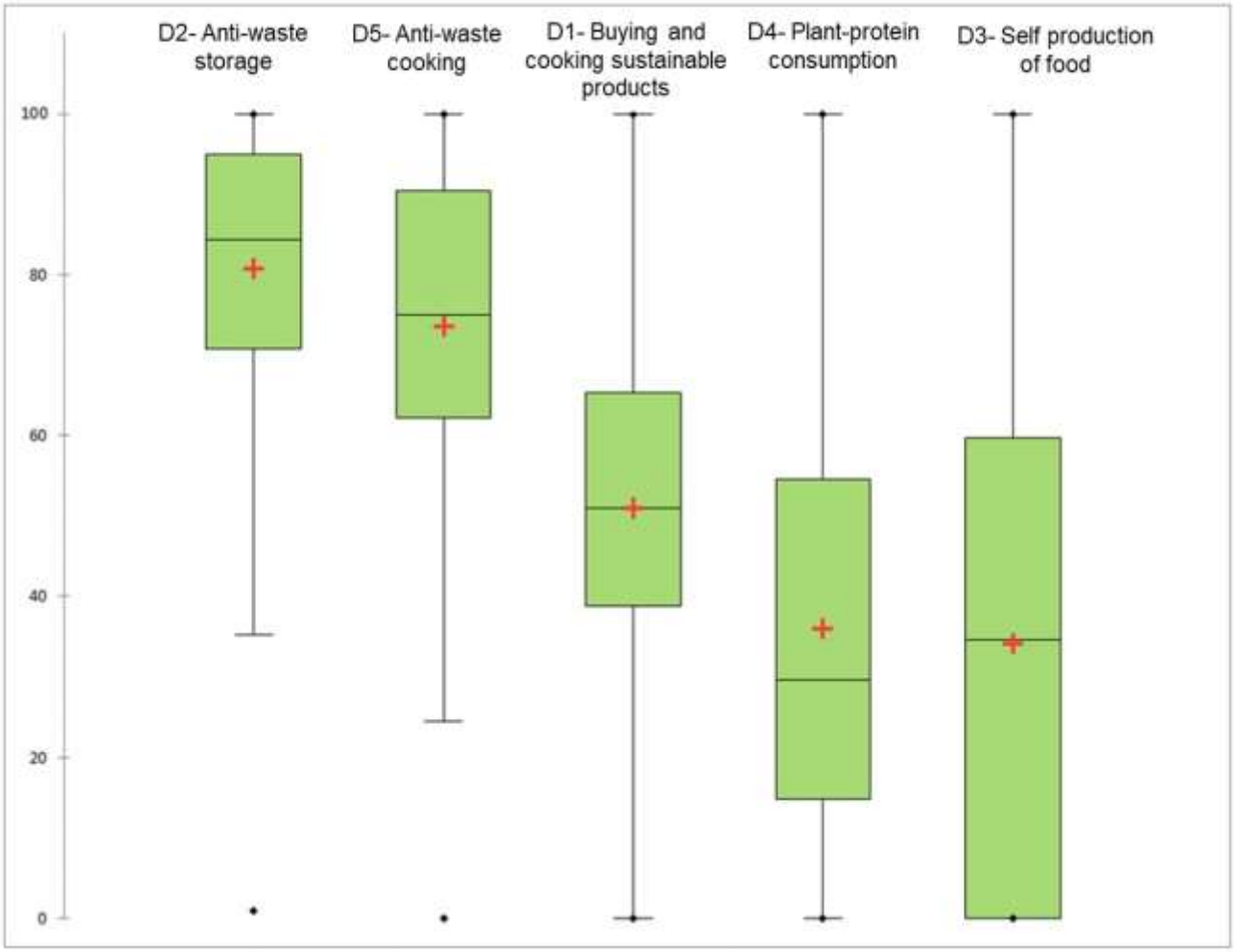

Figure 2. Box Plot showing the scores of the five ESF practices

Figure 3: Diffusion among the French population of the 28 actions associated with ESF measured in this study