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# How institutional food services can contribute to sustainable agrifood systems? Investigating legume-serving, legume-cooking and legume-sourcing through France in 2019

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Received: 10 May 2020 / Accepted: 22 March 2021 / Published online: 15 April 2021  
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## Abstract

Legumes are essential to agrifood sustainability transition. Their nutritional values contribute towards healthy diets, a reduction in animal-based protein consumption and in nitrogen fertilization in crop rotations, therefore meaning a reduction in agricultural greenhouse gas emissions. However, legume consumption remains low in Europe, and institutional food services (IFS) could be an important lever for fostering new eating habits. This study aims to investigate legume use in IFS and identify brakes and levers in their promotion. We built a socio-technical framework to analyse: frequency and diversity of legumes served; cooking practices and uses of legumes in dishes, including alternative (vegetarian/vegan) dishes; and legume-sourcing strategies through supply chain organisations and eco-labels. We addressed a wide survey to IFS kitchens in France, the largest IFS sector in Europe. Based on 383 complete answers, we have revealed heterogeneous IFS practices through clustering methods. This first and original study demonstrates how even if they are few in number (16%), kitchens that develop legumes the most are also those with the strongest sustainability profile (more alternative dishes, local and organic sourcing). Moreover, our clustering analysis revealed that self-managed and medium-sized kitchens are more committed to sustainable practices regarding legumes. Legumes are least served in the Education segment. We discuss ways to foster legumes through the IFS sector, based on cooks' training, recipes and technical infrastructures, and consumer recognition of legume benefits.

**Keywords** Catering · Sustainability transition · Pulses · Soya · Plant protein · Alternative dishes

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## Introduction

One main issue of sustainable diets is to promote eating habits that are good for both human and environmental health (FAO, 2012). This issue represents a great challenge for agrifood systems, and new concepts have been developed such as “nutrition-sensitive agriculture” (Jaenicke & Virchow, 2013), “ecological public health” (Lang & Rayner, 2012) or “environmental nutrition” (Sabaté, 2019). Each one calls for a more integrative conception of food and agricultural systems (Garnett, 2011; Hallström et al., 2015; Meynard et al., 2017).

Among the levers for a sustainability transition of agrifood systems, developing legumes presents both environmental and nutritional benefits. Legumes include soya and pulses (crops such as lentils, beans or chickpeas). Firstly, they mean a reduction in nitrogen fertilization through crop rotations, thereby contributing to reducing greenhouse gas emissions (e.g. Peoples et al., 2019). Secondly, they contribute towards improving nutrient balance particularly in fibres and proteins, especially in regard to issues on reducing animal-based protein consumption (Hallström et al., 2015; Marlow et al., 2015; Vainio et al., 2016). Nevertheless, the re-launching of legumes in Western countries faces lock-ins, in both production and consumption, and particularly in Europe (Magrini et al., 2016, 2018). On the production front, the challenge is to promote sustainable farming systems that include more legumes with more diversity, without an increase in imports which are already high. On the consumption front, compared to major crops such as cereals, legume consumption is very low: 4.7 kg/year/person for pulses and 110 kg/year/person for wheat (Eurostats). Legumes require soaking and longer cooking times, are often associated with digestive problems (flatulence), have an old-fashioned image and are subject to “erroneous and limited mental representations” about how to cook them and associate them with other ingredients to create tasty and healthy dishes (Melendrez-Ruiz et al., 2019). In addition, there is a clear lack of innovative pulse-based foodstuffs (Niva et al., 2017; van der Weele et al., 2019). Finding ways to increase legume consumption is difficult, as it is not easy to change eating habits.

This paper investigates a specific sector considered as a great driver for agrifood sustainability transition: food services, also known as catering<sup>1</sup>. Food services is an expanding sector, influencing eating habits and also impacting agrifood systems through their food supply chain organisations. Traditionally, catering is divided into two categories (Bourlakis & Weightman, 2003; Edwards, 2013): (i) the “profit sector” that comprises profit-orientated establishments such as restaurants, fast-food chain outlets, cafes, takeaways, pubs, leisure and travel catering outlets and (ii) the “cost food services sector”, which typically refers to non-profit catering activities for businesses, education and healthcare, often labelled as “institutional food services” (IFS). The IFS sector is daily frequented by employees, pupils, students, patients and the elderly in workplaces, schools, universities, hospitals or retirement homes.

Our study focuses on the IFS sector, being deemed more likely to influence eating habits than the profit-orientated sector (as assumed by French public policies through, for instance,

<sup>1</sup> As explained by Edwards (2013:223), “food services” (UK spelling and “foodservices” for American spelling) or “catering” terms describe “the serviced provision of food and beverages (meals) purchased out of the home but which may be consumed both in and out of the home”.

the obligation to introduce at least one vegetarian meal every week in school canteens since the 1st November 2019). Hence, the objective of our study is to describe legume uses in IFS in order to identify brakes and levers for their promotion in IFS, particularly with regard to sustainable practices, such as their use in vegetarian dishes.

We focus on France where legume consumption is very low (2 kg/year/person, Graph'Agri, 2019) but which provides the highest number of meals served through the IFS sector in Europe (4 billion per year). We considered the two models dividing the IFS sector (Stahlbrand, 2016; Xerfi, 2015): the *contracting-out model* (40% of the IFS market in France and the largest in Europe) with around 1000 private companies, under contract with institutions or companies that do not directly manage their own catering services, and the *self-managing model* (60% of the French IFS market), where institutions or companies manage their own catering services<sup>2</sup>.

Moreover, whilst several studies advance the idea that the IFS sector is a facilitator in promoting sustainable agrifood systems (Edwards, 2013; Graça et al., 2019; Jones et al., 2019; Vainio et al., 2016), only some take into account both environmental and nutritional issues. Most studies deal either with questions of waste reduction (e.g. Derqui et al., 2018; Martin-Rios et al., 2018), food safety (e.g. De Boeck et al., 2019), nutritional and dietary standards in meals (e.g., Vieux et al., 2013, 2018), health (e.g. Decataldo & Fiore, 2018) or local supplying (Orlando et al., 2019; Stahlbrand, 2016). But none of them consider IFS sustainability transition in a more integrative way. To do so, we built a socio-technical analytical framework on three main dimensions: (i) frequency and diversity of legumes served; (ii) cooking methods and alternative dishes (vegetarian/vegan)<sup>3</sup> with legumes; and (iii) legume-sourcing through supply chain organisations and eco-labels.

We used several sources of information (open-ended interviews, literature and reports on the IFS sector) to build a wide survey addressed to IFS kitchens in France between April and August 2019 (i.e. before the experimental obligation to introduce vegetarian meals in school canteens). We selected 383 complete answers to describe kitchens' practices including legume uses. Through clustering methods, we identified heterogeneous profiles regarding legume uses and commitment to sustainability. This study provides original insights on the levers to develop legumes in a sustainable way, especially to support the development of vegetarian dishes.

Section 2 marks out the analytical framework. Section 3 explains the methodology we followed. Section 4 presents and discusses the results. Section 5 concludes.

## A socio-technical analytical framework to analyse the drivers of legumes development in the IFS sector

Our integrative approach focuses on three main dimensions: *legume-serving* subject to consumer preferences and dietary guidelines (2.1), *legume-cooking* methods along with

<sup>2</sup> Whichever the model, IFS concern a wide variety of guests, both in number and in type: from over 10,000 meals per day for metropolitan schools or major administrations to few meals in rural retirement homes.

<sup>3</sup> By alternative dishes, we consider both vegetarian and vegan dishes. As underlined by Dagnelie and Mariotti (2017), there is no clear definition of such dishes in the literature, and we adopted the following: vegetarian dishes refer to the exclusion of meat, fish and seafood but not eggs and dairy products; vegan dishes refer to the exclusion of all animal-based products.

technical and food safety constraints (2.2) and *legume-sourcing* through supply chains (2.3).

### **Serving legumes: a trade-off between consumer preferences and dietary guidelines**

Consumption is influenced by the intake of recommended daily nutrients diffused by public authorities and used by caterers. There has been no specific promotion in the past concerning legume consumption. But since 2019, French public dietary guidelines on pulses consumption have changed, arguing we should “eat pulses at least twice a week”. Yet nutritional rules are recommendations and not in any way compulsory except for schools for which caterers must respect certain nutritional rules<sup>4</sup>. Therefore, caterers can be proactive or not in promoting sustainable diets with more legumes. Moreover, canteens adapt their meals to their guests’ characteristics and expectations. Tsui and Morillo (2016) argued that cooks (or kitchen supervisors) are central actors in the management of all these dimensions that impact the composition of meals; they underlined that, beyond dietary guidelines, cooks take into account consumers’ varying preferences in order to maximise “food consumption and enjoyment”. Which means that if consumers themselves do not recognise the values in eating legumes, cooks will lack motivation in proposing legumes on a regular basis; and also, cooks’ skills will be determinant in managing to produce tasty-enough meals with legumes to increase legume popularity.

Eating legumes is often linked to animal-based consumption reduction in literature (e.g. Niva et al., 2017; van der Weele et al., 2019) as well as in NGOs reports (e.g., Poux & Aubert, 2018; WWF, 2017). Recent studies show that vegetarians consume more legumes for their richness in protein (Figueira et al., 2019) and that, in general, consumers associate pulses with a vegetarian diet (Melendrez-Ruiz et al., 2019). Health also influences eating habits: for instance, diabetics could consume more pulses to help control blood sugar levels. Environmental awareness influences consumption as well: consumers of organic products consume more legumes than the average population (Solagro, 2019). In France, 34% of consumers declare to be flexitarian<sup>5</sup>, which could lead to an increase in legume consumption.

### **Cooking legumes: cooks’ skills, technical and food safety constraints**

Most pulses suffer from certain cooking disadvantages. They require soaking and take longer to cook. Also, certain consumers encounter residual digestibility problems even after correct soaking times. However specific cooking recipes such as adding spices and adopting precise cooking times could solve this issue. Kitchens’ abilities to serve more legumes will then depend on the cooks’ skills in preparing appetising legume-based meals, notably in adding legumes to alternative dishes aimed at reducing meat consumption (Graça et al., 2019).

Another type of constraint could be linked to the organisation of the cooking chain. Two models of catering services differ from each other in regard to

<sup>4</sup> In France, see the legislation NOR: AGRG1032380A.

<sup>5</sup> From Kantar World Panel: <https://www.kantarworldpanel.com/fr/A-la-une/flexitariens-nl48> [Accessed 10th December 2020]

where the foods are prepared and delivered (Fusi et al., 2016): the “deferred system” (central kitchens send out prepared dishes or pre-processed ingredients/meals to satellite sites) and the “cook-served system” (the meals are cooked and served on the same site). In the deferred system, the cook-warm chain can have an impact on the taste and quality of legume-based dishes, seeing as the time difference between preparation in the catering centre and consumption can be several hours or days, depending on the method used in preservation. Hence, various technical constraints could lead to different strategies in the choice of raw materials and dishes to be served with legumes. The various structures in which they are embedded also could allow us to tackle technological or logistic constraints in different ways.

### **Sourcing legumes: foodstuff categories and supply chains**

Whilst the modern agrifood system tends to favour large purchase platforms (central purchasing, wholesalers), shorter supply chains and local distribution networks are currently becoming a trend; local supply chains are mostly defined within region borders as mentioned and adopted in the study of Orlando et al. (2019). The EU strategy is targeted at promoting a re-organisation and re-localisation of the food system that improves local economic sustainability and social cohesion. In France, local produce is increasingly a central purchase criterion for consumers (Le Velly & Bréchet, 2011 ; Praly et al., 2012) and authorities (through “Territorial Food Plan”, for instance), aimed to counteract the negative externalities of globalisation (e.g. dependence on foreign goods and international market prices, energy and GHG emissions due to transport, etc.).

Some actors consider the “creative procurement policy, which takes a holistic view of the food chain” as a strategic target to calibrating production and consumption on a local level (Morgan & Sonnino, 2007: 19). These strategies are strongly promoted based on IFS initiatives such as in the French city Mouans-Sarthoux where school IFS is under a self-managing model using 100% organic foodstuffs and mainly local food (Pérole, 2017).

Besides, French farmers (like all European farmers) face fierce international competition in regard to importation. In France, 70% of legume consumption is imported<sup>6</sup>. But 40% of pulse production is organic<sup>7</sup> since legumes are a main lever for the nitrogen cycle in crop rotation. Therefore, pulses could be a lever for increasing organic sourcing in IFS.

Finally, legumes present an advantage owing to easy storage, their consumption not being restricted to seasons. New industrial food products have been developed to facilitate the consumption of pulses such as ready-to-cook pulses; and some agrifood firms consider the IFS market as a target strategy for familiarising consumers with new products (Lascialfari et al., 2019).

<sup>6</sup> Estimated data from COSELAGE project: <https://www6.inrae.fr/coselag/Livrables>

<sup>7</sup> From French Organic Data: [https://www.agencebio.org/wp-content/uploads/2020/07/DP-AGENCE-BIO-CHIFFRES-2019\\_def.pdf](https://www.agencebio.org/wp-content/uploads/2020/07/DP-AGENCE-BIO-CHIFFRES-2019_def.pdf)

*Synthesis of the analytical framework on legume practices in the IFS sector*

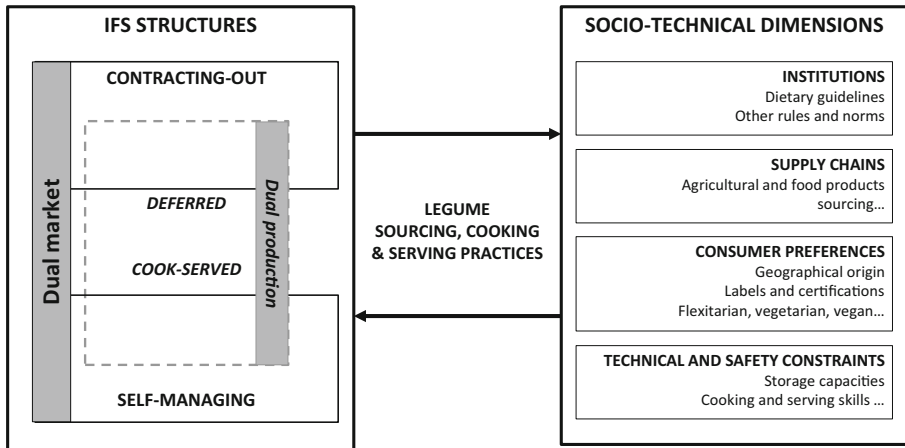


Fig. 1 Synthesis of the analytical framework on practices regarding legumes in the IFS sector

## Synthesis

Based on those main dimensions that shape legume-sourcing, cooking and serving practices in the IFS sector (Fig. 1), our study is aimed at understanding those current practices of caterers.

## Research design

This research is based on a wide survey addressed to cooks and kitchen supervisors (3.1). Based on clustering methods, we identified various profiles of caterers (3.2).

### An original online survey addressed to IFS kitchens in France

First, based on web searching, we identified the main actors of the IFS sector, notably professional associations that represent catering operators, who we contacted for open-ended interviews (see Table A1 in Supplementary Material). These interviews led to a better understanding of the various dimensions that influence caterer practices and helped us to build our survey.

Secondly, we addressed the survey to IFS kitchens (production sites) between April and August 2019, through Lime Survey online application. As underlined by Tsui and Morillo (2016), cooks (but also kitchen managers or purchasing and nutrition managers) are recognised to have a major role in the IFS sector, and we considered them as relevant information providers.

The survey (free available<sup>8</sup>) was organized through 10 sections:

1. Description of the production site (kitchen): cooked–served or deferred production system, self-managing or contracting-out models, localisation, quantity of meals served by segments (guests)
2. Serving practices regarding legumes: frequency, diversity, labels
3. Sourcing and purchasing practices regarding legumes: legume-based products types, supply chain organisation, products' geographical origins, structure's policy on food sourcing
4. Knowledge as regards nutritional intakes of legumes
5. Legumes in alternative dishes
6. Perceptions on guests' expectations regarding legumes
7. Difficulties encountered with legumes
8. Areas for improvement regarding legumes
9. Kitchen's sustainable food programs
10. Other general information: employees, price invoiced to the guest, menus elaboration, dietary guidelines, networks and partnerships

The survey was tested with several operators previously interviewed and with four kitchen managers (of various kitchen types) not previously interviewed. The survey was diffused on a national scale through various channels: public authorities, volunteers we identified during the interviews, the newsletters of main IFS operators and through professional associations in the IFS sector. We obtained 568 usable responses of which 383 were complete.

Compared to data collected from professional reports, the representativeness of answers presents a small bias in regard to the two IFS models with a slight overrepresentation of self-managing models (Table A2 in Supplementary Material) and, within contracting-out kitchens, an imbalance in the amount of responses for some main companies operating in the French IFS sector (Table A3 in Supplementary Material). As regards to the type of production model (deferred or on-site) and the size of the kitchens interviewed, we managed to get responses from a suitable diversity of sites: from small kitchens serving less than 80 meals per week to the biggest ones serving over 15,000 meals a week. Concerning segments, some PCCs are specialised in specific segments, especially in the cases of healthcare and childcare. Otherwise, most caterers operate with several segments.

### **Clustering methods for identifying caterers' profiles**

The clustering process helped us identify caterers' profiles in regard to their practices with legumes. It was carried out in three stages, by using the free FactoMineR package<sup>9</sup>. We first launched different multiple correspondence analysis (MCA), by varying the dataset from answers to the survey. This step highlighted the strong impact of missing data, leading to the elimination of 185 respondents (kitchens) who did not answer certain questions we selected for the analysis. Thus, 383 kitchens were selected,

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<sup>8</sup> <https://doi.org/10.15454/QR1XMS>

<sup>9</sup> <https://cran.r-project.org/web/packages/FactoMineR/index.html>



and Table 1 presents the frequencies of the variables' modalities used for the clustering. An MCA was carried out on this population in order to obtain final numerical axes, which concentrate main statistical information (inertia) in the first ones. Secondly, from the 35 axes generated by this MCA, we selected the first 12 (56% of the total inertia) to perform a hierarchical cluster analysis (HCA). HCA provides a classification by successive groupings. Table 2 presents the total by groups of the HCA dendrogram: after analysing different partitions, we decided to keep the 6-groups classification. Thirdly, we reinforced it with a K-means cluster analysis, and Table 3 presents the correspondence matrix. The K-means clustering step increases variance between classes whilst reducing variance within classes (Table 4) to obtain our final 6-groups classification.

## Results and discussion

First, we present descriptive statistics on legume uses to have an overview of the current situation in French IFS (4.1). Then, we present the clustering that reveals major heterogeneity in IFS on the practices regarding legumes and commitments to sustainability (4.2). Those results lead to several insights in terms of policy implications (4.3).

### Main trends in caterers' practices regarding legumes in France

Firstly, we observed a diversity in legume-serving frequencies (Table 5).<sup>10</sup> Sixty-one percent of caterers serve legumes less than twice a week, which is below current national dietary guidelines. Most of them serve only lunches 5 days a week, so legume-serving frequencies do not seem high enough to encourage consumers to shift towards eating more legumes, seeing as private legume consumption is very low. However, 21% of caterers serve legumes over twice a week, and even some serve them every day (8%). On the whole, contracting-out kitchens serve legumes more frequently. This could be explained by the fact that they receive information more frequently via associations' newsletters who communicate on dietary guidelines.

Furthermore, legume-serving frequencies are lower in the education segment (66% serve legumes less than twice a week) compared to the business segment (47% serve less than twice a week). The healthcare segment presents the highest legume-serving frequency (38% serve legumes less than twice a week), probably due to a higher awareness of their nutritional interest by guests and the fact that legumes are more common with the elderly.

Comparing *contracting-out* and *self-managing* services, the former presents higher serving frequencies in business and healthcare, but equal frequencies in education. As regards to the type of production, on-site kitchens present higher frequencies. Caterers who have been proposing alternative dishes for a longer time also serve legumes more frequently: 35% of caterers who have been proposing alternative dishes for over 5 years serve legumes more than twice a week, while it is only 17% for the caterers who have been proposing alternative dishes for more than 2 years.

As explained in Section 2, legume-serving results from a trade-off between giving enjoyment to guests and providing food with a sound nutritional profile. On the one

<sup>10</sup> Note also that those frequencies are similar to the whole sample based on  $n = 568$ .

**Table 1** Modality frequencies of the variables used for clustering ( $n = 383$ )

Var. name	Definition	Modalities	Freq.
General characteristics			
Number of guests	Guests served by the kitchen per week	High — more than 1500 Medium — between 600 and 1499 Low — between 200 and 599 Very low — less than 199	85 112 126 60
I/F/S model	Self-managing or contracting-out	Self-managing Contracting-out	302 81
Kitchen type	On-site or deferred (central kitchens)	On-site kitchens Central kitchens	265 118
Segment served	Type of guests (segment) served, some kitchen could serve several segments	Business Education Childcare Healthcare	57 292 90 71
Sustainable food program	Kitchen declaring a sustainable program*	Yes No	214 169
Alternative dishes	Alternative dishes (vegetarian or vegan) served	Yes No	237 146
Practices regarding legumes			
Legume-serving frequency	Frequency per week	High — more than twice a week Medium — twice a week Low — less than twice a week	80 71 232
Legume diversity	Score on variety of legumes served combined with the variety of dishes used**	High — score more than 10 Medium — score between 5 and 9	94 219

Table 1 (continued)

Var. name	Definition	Modalities	Freq.
Legume popularity	Legumes' popularity among guests, perceived by kitchens' managers. Scale 1 (very low) to 5 (very high)	Low — score less than 5 High — score of 4 or 5 Medium — score of 3 Low — score of 1 or 2 High — score of 4 or 5	70 51 179 153 169
Difficulty to cook legumes	Number of various legumes declared as easy to cook	Low and medium grouped — score less than 3	214
Geographical origin of legumes	Main geographical origin of most frequent legumes served	Regional National European or World	169 135 79
Type of supply chains	Use frequency of different supply chains	Directly from farmers — sometimes or regularly Directly from farmers — never From storage organisations — sometimes or regularly From storage organisations — never From agrifood industries — sometimes or regularly From agrifood industries — never From central purchase platform — sometimes or regularly	109 274 78 305 157 226 337
Organic legumes	Score on the number of various legumes regularly served as organic***	From central purchase platform — never Often — score between 3 and 6 Rarely — score between 1 and 2 Never — score of zero Do not know	46 55 90 173 65
Types of legume-based products used	Frequency in using (Never, Sometimes or Regularly)	Raw legumes to be cooked — Regularly Raw legumes to be cooked — Sometimes	246 84

Table 1 (continued)

Var. name	Definition	Modalities	Freq.
		Raw legumes to be cooked — Never	53
		Dried ingredients (flour, peptides, pasta...) — Regularly	143
		Id. (flour, peptides, pasta...) — Never or Sometimes	240
		Frozen legumes — Regularly	87
		Frozen legumes — Never or Sometimes	296
		Vacuum-packed legumes — Regularly	45
		Vacuum-packed legumes — Never or Sometimes	338
		Canned legumes — Regularly	140
		Canned legumes — Never or Sometimes	243
		Ready-prepared legumes — Regularly or Sometimes	75
		Ready-prepared legumes — Never	308
Price factor in elaborating meal	How respondents declare price factor in supply choices	Price is a main determinant in legume supplying	216
choice		Price is not a main determinant in legume supplying	167

Note: \*Open-ended interviews allowed us to identify four main sustainable programs developed for French IFS kitchens: “En cuisine”, “Mon restau responsable”, “Territoire bio engagé”, “Ici je mange local”.

\*\*Respondents completed a table crossing the following legumes — lentils, chickpeas, dried beans, faba beans, split peas, soya — and the dishes in which they serve them, starters, salad bars, main dishes, alternative dishes, desserts. Each cell filled accounted for one point for the diversity score

\*\*\*Respondents completed a table crossing the following organic legumes — lentils, chickpeas, dried beans, faba beans, split peas, soya — and their frequency of use. Each species served “often” accounted for two points and “rarely” for one point

**Table 2** Successive groupings from the hierarchical cluster analysis ( $n = 383$ )

Partitioning groups	Total by groups					
2	240			143		
3	240			51	92	
4	69	171		51	92	
5	69	171		51	30	62
6	69	62	109	51	30	62
<i>Cluster numbering for the partition into 6 groups</i>	2	5	4	6	3	1

hand, most respondents estimate that legumes are not very popular among guests, particularly among children and teenagers. In the education segment, only 12% of respondents consider that legumes are popular among guests: against 28% of the respondents in the business segment and 21% in the healthcare segment. We also observe that *low legume-popularity perceived by cooks* is strongly correlated with *low frequency* serving. Those results confirm that, according to respondents, legumes are not very attractive to consumers. Nevertheless, the business segment is more committed to serving legumes. Over 88% of all respondents consider that legumes contribute to healthier and more sustainable diets and 99% agree with the need to promote legumes as a main lever in favouring sustainability shifts among consumers. In addition, whilst digestive discomfort is often cited to explain low consumption of pulses, only 60% of respondents agree with this argument. Most of them recognise also their richness both in fibre and protein.

Legumes are unequally served in terms of species. Lentils are the most common (71% of respondents regularly serve lentils), followed by beans (57%), chickpeas (27%), soya (12%), split peas (10%); faba beans come in last with only 4% of respondents serving them regularly. Another interesting result is that 55% of respondents declare to have never served faba beans, 36% have never served soya, 34% have never served split peas and 9% have never served chickpeas. Therefore, there is a high diversity of practices according to species. Through a post-calculated score, based on the legumes served in the various dishes constituting a meal, we defined a *legume diversity score* (Table 1). There is a high amplitude of scores, differently correlated with the serving frequency, however seemingly more correlated with cooks' skills.

**Table 3** Correspondence matrix between HCA and K-means

Cluster number from	CHA	2	5	4	6	3	1
K-means	Total bycluster	69	62	109	51	30	62
2	62	45	0	4	8	1	4
5	56	1	42	12	1	0	0
4	107	13	10	82	1	0	1
6	48	2	3	2	38	1	2
3	36	7	2	2	0	24	1
1	74	1	5	7	3	4	54

**Table 4** Inertia decomposition from the HCA and K-means for the partitioning in 6 clusters

Inertia	Total	HCA		K-means	
		Inter	Intra	Inter	Intra
Value	288.33	75.56	212.77	90.68	197.65
Share of inertia	100%	26.21%	73.79%	31.45%	68.55%

Indeed, capabilities and skills are required to develop legumes in diets. We also observe that low popularity consideration is strongly correlated with the fact that cooks admit they encounter difficulties cooking legumes, whilst those declaring high popularity rates confirm not having difficulties in cooking them. As a result, we observe a division between respondents: one half consider that cooking legumes is difficult while the other half does not.

Overall, if most respondents consider legumes not popular among guests, 80% agree that legumes remain *interesting* and *innovative* products. Seventy-five percent agree with the need to have more dried legume-based ingredients (such as flour or pasta) and also more variety in legume grains (88%), whilst only 33% request more pre-cooked legume products or dishes. Most respondents (92%) recognise that having more recipes at their disposal will help them and emphasized the need of training (89%) in this respect. Besides, whilst legumes may represent a technical constraint that could be solved by using canned, vacuum packed or pre-cooked products or dishes, raw legumes remain the main type of product used, and 80% of respondents declare they never use pre-prepared (or already cooked) legumes.

Developing alternative dishes should favour legumes because of their richness in proteins. But the survey reveals that alternative dishes development is quite recent: only 13% of the respondents have been serving them for more than 5 years and 23% for more than 2 years. 40% have been doing so for less than 2 years or are planning to. In the business segment, alternative dishes have existed for longer periods. Twenty-six percent of the respondents systematically use legumes for alternative dishes and 52% on a regular basis, mainly in association with cereals. Therefore, alternative dishes remain a major driver of legume development. Legumes can be a source of innovation, and they become more common, even in components where they are usually absent in the IFS sector such as desserts with, for example, newly developed recipes using chickpea cooking water, such as vegan chocolate mousse often quoted.

**Table 5** Serving frequency of legumes in the IFS sector

Serving frequency	Contracted-out	Self-managed	Both
Less than twice a week	44% (36)	65% (196)	61% (232)
Twice a week	21% (17)	18% (54)	19% (71)
More than twice a week	23% (19)	11% (32)	13% (51)
Everyday	11% (9)	7% (20)	8% (29)

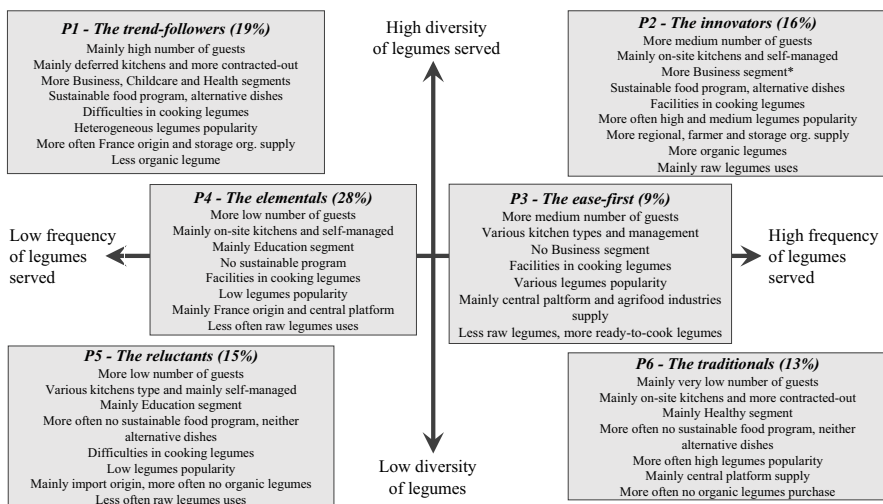
Number of respondents into brackets. Pearson's Chi-squared test:  $p$  value = 0.0024,  $df = 3$

Finally, concerning supply chains, wholesaling or central purchasing remain the main types regularly used by 88% of the respondents (only 12% declared to never use this type of sourcing). Few caterers regularly use alternative supply chains such as direct purchasing from farmers (8%) or from agricultural cooperatives (7%). But nearly 42% of respondents declare direct purchasing from farmers is a priority action for the next few years; and for more than 76%, developing regional sourcing is also a priority. We also observe that on-site kitchens more frequently use regional or national sourcing than the deferred system. For more than 69% of the respondents, developing organic sourcing is also a priority for the coming years, given the fact that certain legumes served regularly are organic (20% of the respondents serving beans regularly served organic beans, 33% for lentils). But it is important to note that most caterers have never served organic legumes (62%).

### Kitchen profiling based on their characteristics and practices with legumes

Based on selected variables from this survey (Table 1), we conducted a clusterisation defining 6 main profiles of kitchens as explained in Section 3. We reported the statistical significance of the variables used in the clusterisation showing that variables on legume uses and kitchen size are the most discriminant (Table A4 in Supplementary Material); the statistical significance of the modalities contributing to each cluster from K-means clustering (Table A5 Supplementary Material) and from which the profiles depicted are established.

Figure 2 synthesized the characteristics of each cluster through two main axes: the diversity of legumes served and the frequency of legumes served by week. The modalities described in each cluster are the ones having a  $p$  value < 10%, most of them being < 1%. From these clusters, we described six profiles of kitchens, showing



**Lecture:** The modalities considered in the clustering are depicted in Table 1. Only the modalities which were statistically significant ( $p$ value < 0,10) in each of the 6 clusters are mentioned in the figure (P1 corresponds to Cluster 1, etc.) and Table A4 (in Supplementary Material) provided all the results from the k-means clustering method. Those profiles are positioned on two discriminant axis: the frequency and the diversity of legumes served. As recalled in Table 1, the diversity variable is a score based on both the diversity of legumes species and variety of dishes in which legumes are incorporated. \* Business segment is more represented in Cluster 2 with a  $p$ value of 0,15.

**Fig. 2** Kitchen profiles on their characteristics and practices regarding legumes from the six clusters

that there is no unique link between the frequency of legume-serving and the other variables considered. In particular, we observed various commitments towards the sustainability dimensions of diets discussed in Section 2, and a clear result appears: the kitchens that develop most legumes (both in frequency and diversity) are also those with more sustainable profiles according to the variables considered (such as local and organic sourcing and alternative dishes development).

### Profiles with low legume-serving frequencies: P1, P4 and P5

**P1** — The “trend-followers” concern mainly the biggest kitchens (serving over 1500 meals a day, almost absent from the other clusters) and which are more often under contracting-out models. They serve various segments but more frequently the childcare, business and healthcare segments. The childcare segment is the most frequent (72% of the class). Even though they are characterised by low legume-serving frequencies, they propose a diversity of legumes through various types of dishes. The low frequency in legumes could appear in opposition to the fact that these kitchens are frequently engaged in sustainable food programs and serve alternative dishes. Hence, they seem to follow consumption and societal trends but are not at the forefront, compared to those also presenting sustainable food programs and alternative dishes but also serving with a higher frequency and diversity of legumes (P2 — *the innovators*). The low legume-serving frequency of P1 could be explained by their size, as providing large quantities could prove problematic (this point was also mentioned during interviews) especially to obtain organic pulses (explaining why they are rarely served in this cluster) or to obtain French origin. They do not favour products facilitating legume-use (such as vacuum-packed, frozen, ready-to-use, etc.). Platform supply purchasing is more frequent in this cluster. Furthermore, cooks more frequently declare that legume-cooking is not easy: such judgements might be reinforced because of the large quantities of meals they need to provide.

**P4** — The “elementals” are characterised by elemental practices regarding legumes. They don’t have innovative or differentiating practices regarding legumes. It concerns mainly on-site and self-managed kitchens in the education segment (98% of the class) with low number of guests. With a low legume-serving frequency, low diversity and low popularity, this profile however declares not having problems with legume-cooking, probably because they use less raw legumes. Regarding geographical origin, P4 relies on national sourcing. But it presents weak sustainable commitment: organic legumes are never used, neither direct-to-the-farm supply; the majority do not have a sustainable food program, neither serve alternative dishes.

**P5** — The “reluctants” are quite similar to P4, gathering mainly self-managed kitchens in the education segment (93% of the class) with low number of guests, but with both kitchen types. Like P4, P5 presents weak sustainable commitment: organic legumes are never used nor direct-to-the-farm supply; most of them do not have a sustainable food program nor serve alternative dishes. However, P5 presents a lower diversity of legumes than P4 and relies less on raw legumes but, above all, presents difficulties in cooking legumes. In addition, P5 relies more on imports (EU and



worldwide) than P4. All these indicators conducted us to qualify P5 as reluctant because they do not adopt any of the dimensions contributing to sustainable diets.

### Profiles with high legume-serving frequencies: P2, P3 and P6

**P2**— The “innovators” are more medium-sized kitchens, mainly self-managed. They serve various segments, but less frequently healthcare or childcare segments; therefore, this class concerns mainly education (81%) and business (21%). Like group P1, they have sustainable food programs and serve alternative dishes more frequently, but they take this further as they also show the highest serving legume-frequency and diversity. In addition, most cooks of this class declare legumes are easy to cook, and popularity is high. Their origin is mostly regional. They also more frequently declare using short legume supply chains with farmers or storage organisations and regularly serving organic legumes. They mainly use raw legumes and more frequently legume-based dried ingredients (flour, pepites — new product like semolina — etc.) compared to the whole sample. Finally, only in this cluster (as for P3), the modality “price is not the first determinant of legume purchase” is significant.

**P6** — The “traditionals” concern mainly the smallest kitchens of the sample (less than 200 guests served per week) and are more frequently associated with the contracting-out model. They are the opposite to P2 (the innovators) as whilst this group presents high frequencies of legumes, diversity is low. Furthermore, most of these caterers do not follow sustainable food programs nor serve alternative dishes. Most of them never use direct farming or storage organisation supply chains and do not purchase organic legumes. Therefore, their commitment towards sustainability could be qualified as low. Their high frequency of legume-serving could be then explained by the kind of guests they serve: the healthcare segment (that includes the elderly) is over-represented in this class (70%). This segment is generally linked to a higher recognition of the nutritional intake of legumes and the fact that the elderly are more used to these products compared to younger people and used to a low diversity of legumes types and dishes.

**P3** — The “ease-first” concern medium-sized kitchens — not predominantly associated with any types of kitchen models or management. The business segment is very little served by this group; otherwise this class gathers various segments. This profile seems to seek “easy catering” as in this group, the caterers regularly use canned, vacuum-packed, frozen or ready-to-cook legumes and very rarely raw legumes. Legume-serving frequency is high with quite a lot of diversity, and most cooks declare cooking legumes is easy. The main supply chain is central platforms. In this group, price is not the main determinant of legume purchasing, corresponding to the fact that the type of products frequently used is more expensive than raw legumes. They declare more frequently that the origin is not national, but most of them declare they follow a sustainable food program.

Hence, this clustering reveals significant heterogeneity in caterers’ profiles concerning legume issues: some caterers are already strongly committed to developing sustainable practices with legumes, and others are still far from implementing such practices. This result confirms the necessity to develop and implement new policies for promoting legumes in a sustainable way, and most of the IFS professional organisations we interviewed recognised that up until now, no specific action has been carried out.

## Policy implications

How can sustainable practices be scaled-up in the IFS sector? The various dimensions analysed provide several insights for policymakers in fostering sustainable diets that include legumes. In addition, these insights could lead to a new research agenda for further investigation of the reasons why the different models of caterers do not present the same propensity to use legumes and adopt sustainable practices.

Using more legumes for sustainability is a recent issue and has not yet benefited from any specific fostering public policies. The adoption of new dietary guidelines by French public authorities for legumes in 2019 has not yet been followed up by any specific promotion through the media or public communications. Hence, any caterer already committed to sustainable practices with legumes can be highlighted as examples by policymakers and stakeholders. Our study reveals that such operators exist, even though they are a minority: the *innovators* profile concerns 16% of our sample. But considering the characteristics of this profile (mainly middle-sized, self-managed and serving chiefly the education and business segments), we must take a closer look at the following points.

1. From the clustering, our results suggest that in the IFS sector, the kitchens most committed to sustainability are mainly self-managed; in other terms they that are not enclosed in large private catering companies (PCCs). As often advanced in *sustainability transition studies*, free thinking opens the way to greater creativity. But no previous study has been developed to assert this point in the IFS sector. Here, it would seem that the self-managing model allows more independence in particular for their supply chains and could be more receptive to emergent trends. Even if PCCs (contracting-out model) promote sound practices — for instance, they are currently developing new recipes with legumes as mentioned during interviews — the most sustainable practices with legumes are already being developed by caterers from the self-managing model. On the other hand, on-site and deferred systems did not seem to be strongly opposed regarding legume practices, notwithstanding the fact that the most innovative profile is mainly composed of on-site kitchens.
2. Comparing the networks of the most innovative caterers, and their exchanges, we can thoroughly grasp the influences that lead to innovative behaviour. These different observations reinforce the idea that adopting sustainable practices is currently more likely to be linked to caterers' immediate surroundings and environment than their ties with professional organisations, as most kitchens declared having few or no interactions with professional organisations. Hence, their personal commitments and the ways they acquire skills, rather than hierarchical injunctions, could influence the adoption of sustainable practices. This opens up a new research agenda focusing on chefs and cooks, seen as key-actors of sustainability transition. This will give us a better understanding of their socio-demographic characteristics, know-how and work conditions, since generally speaking, not much is known about this profession.
3. The selection of supply chains turns out to be an adequate proxy of sustainability profiles. We observed a strong correlation between more legume uses and sustainable chains, such as direct sourcing with farmers. The *innovators*, with the highest

rate of legume frequency and diversity, are definitely those more active in organic and regional supplying. Nevertheless, most of the caterers declared their will to develop regional and organic legume supplying. Therefore, public authorities could foster the re-organisation of the food system to achieve this objective. We also observed that legumes are greatly used in alternative dishes. Overall, these observations suggest that promoting sustainable programs for legumes in the IFS sector could be a step to go further with more extensive programs in food sustainability.

4. Kitchen-size appears to be a main determinant in adopting sustainable practices with legumes: medium-sized kitchens being the most innovative. This could reveal how technical or logistical issues can be resolved more easily in kitchens with higher capacities (economically and spatially) compared to smaller kitchens. On the other hand, the biggest kitchens encounter more difficulties in sourcing and cooking large quantities of legumes, leaving also less scope for organic and local supplying, whereas smaller kitchens seem more flexible by varying their supplying methods. The size variable should be explored further in order to understand if infrastructures and technical constraints are main obstacles to sustainable practices. Hence, it raises the following question: which size for IFS (number of guests served) should be fostered to improve the implementation of sustainable practices?
5. Training and recipes appears more important than for ready-to-cook legumes. Indeed, legume popularity among guests (perceived by cooks) was closely related to serving frequencies and cooks' skills. Thereby, when cooks declare to have difficulties in cooking legume, we also observed lower frequency and less popularity, which could suggest their guests do not enjoy the way legumes are being cooked. Cooks' skills appear crucial since most of the respondents clearly request more recipes and training regarding legumes. In addition, the majority of respondents also mentioned a greater use of raw legumes (also confirmed through the open-ended interviews). Therefore, whereas ready-to-cook or other pre-processed legumes could be a lever to make using legumes easier, this is not a preferable lever in IFS.
6. Any sustainable food policy in the IFS sector must take into account both cooks and guests. Most respondents (97%) mentioned that developing legumes in the IFS sector requires specific policies aimed at increasing consumer (guest) recognition of the benefits of eating legumes. This is in line with the suggestion of Vaino et al. (2016), in terms of public policies, to develop "consumers' culturally accepted ideas of healthy and 'natural' foods". In particular, as our survey reveals that legumes are less served in education segment and taking into account that food habits are strongly related to childhood and teenage years, it appears crucial that public policies should start implementing the promotion of legumes in this segment. The *innovators* profile revealed that some caterers already serve more legumes with higher diversity for this segment. Additional studies could focus on the guests themselves served by those *innovator* caterers in order to understand how food choices follow to the home front but also how guests could influence caterers' choices through social interactions.

## Conclusion

Legumes are highlighted as an important lever for more sustainable and healthy diets, and IFS services impact agrifood systems by serving millions of people every day. However, we know very little about the practices of caterers and nothing at all when it comes to legumes. This first-time study for France contributes towards filling this knowledge gap. In addition, it highlights various commitments to sustainability revealed through specific practices such as local and organic supply or alternative dishes development. We observed that the caterers highly committed to sustainability are few but could be a driving force for the sustainability transition; and further studies focusing on guests to understand how those food choices in IFS spread to the home front are required. This study calls also for comparative studies in Europe. Our framework provides an effective and productive starting point for investigating such issues through the case of legumes, and this framework could be adapted to any other food category.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s41130-021-00146-y>.

**Acknowledgements** Authors acknowledge all the participants in the elaboration of this study and the respondents to the interviews and the survey. Particular acknowledgements are addressed to Muriel Gineste from CISALI, and Marie-Joseph Amiot-Carlin from INRAE, the French Ministry of Agriculture and Food, and everyone who helped us to diffuse it, and Alice Thomson-Thibault for her helpful comments and English editing of the manuscript.

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**Funding** This work was supported by the European Union's Horizon 2020 research and innovation program under grant agreement No 727672 for the LEGVALUE (Fostering sustainable legume-based farming systems and agrifood and food chains in the EU) project 2017-2021.

**Availability of data and materials** The survey used is free available on INRA/DATA repository.

**Code availability (software application or custom code):** Not applicable

## Declaration

**Ethics approval** The authors addressed a survey with legal mentions concerning the fact that the collected data were for the exclusive use of researchers; the analysis respects data anonymization; and that in accordance

with the General Data Protection Regulation (GDPR) and the Informatics and Liberty law, respondents had the right to access, rectify, oppose and delete the information provided.

**Consent to participate** The survey was freely answered by voluntary participants

**Consent for publication** Authors consent for the publication of this article

**Conflicts of interest** The author declare no competing interests.

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