DIVINFOOD

Co-constructing interactive short and mid-tier food chains to value agrobiodiversity in healthy plant-based food

Deliverable D1.3

Report on enabling food environments (existing shops, infrastructures, labels) valuing NUCs-based products

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Executive summary

The aim of this deliverable is that of contributing to DIVINFOOD Task 1.2. The Task focuses on analysing how products made of neglected and underutilised crops (NUCs) are valued in the food environments and in food chains. The core activity of the Task is to collect primary data from actors working with NUCs in the food environments of the 7 countries involved in the DIVINFOOD project, which will then be analysed and described in Deliverable 1.4. In preparation to that, this deliverable provides a literature review of how NUCs have been given value in the food retail environments of the 7 countries.

Objective

The objective of this deliverable is to provide a literature review of how NUCs have been given value in the food retail environments of the 7 DIVINFOOD countries, in preparation for an in-depth empirical analysis.

Rationale:

D1.3 presents the results of a systematic literature review that was conducted in 2023 in order to establish the state of the art on food (retail) environments that value agrobiodiversity and NUCs in particular. In order to do this, we pursued the following sub-objectives that guided our research:

- Establish the state of the art on how food retail environments influence what consumers buy and consume.
- Establish the state of the art on how retail spaces in Europe valorise NUCs.
- Understand how these insights (related to healthy diets) can be adjusted to better understand how food retail environments can make NUCs more "appealing".

The scientific literature in social and agricultural sciences was collected systematically and reviewed in order to achieve the three abovementioned objectives. 26 articles were reviewed and a conceptual framework was established, which will be applied to the analysis of the empirical data that will be presented and analysed in D1.4.

Teams involved:

The work conducted for this deliverable was led by INRAE and carried out in close collaboration with Agri Kulti and the University of Pisa.

The deliverable was reviewed by Samuel Feller, Open Food France, and by the management team (Yuna Chiffoleau, Laurane Desoutter, Cassandra Togna).

1. Introduction

1.1 Background on DIVINFOOD

The context for the development and implementation of the DIVINFOOD project (Co-constructing interactive short and mid-tier food chains to value agrobiodiversity in healthy plant-based food) is one of rapid decline of biodiversity, both globally and also in Europe. The current heavy reliance on a small number of varieties is a threat to food security and deprives consumers of the nutritional quality of other species. Currently, small-scale producers and processors offer local food products valuing neglected and under-utilised species (NUCs) in short chains, thus helping to both reverse the decline in biodiversity and meet this demand. However, they face many challenges, from insufficient availability of suitable varieties to difficulty in developing viable business models.

In light of these challenges, the overall objective of the project is to contribute to reversing the agrobiodiversity decline by producing knowledge and tools to support farmers and small-scale processors to develop short- and mid-tier supply chains which value NUCs and meet consumer expectations of local, healthy, plant-based food. DIVINFOOD focuses on legumes and minor cereals, whose use in short and mid-tier chains is increasing, and whose potential for health and agroecology is high. The production of knowledge and tools, from breeding to marketing, involves citizen-consumers and relies on 9 living labs (LLs) gathering all concerned stakeholders from the 7 partner countries (Denmark, France, Hungary, Italy, Portugal, Sweden, Switzerland).

1.2 Background on WP1: Diversify consumer-producer interactions to guide innovation in short and mid-tier chains and facilitate responsible consumption

DIVINFOOD uses an approach that considers all the activities that occur along the value chain of the NUC – from seed to plate - with a view to valorise NUCs and ultimately increase their purchase and consumption. The first Work Package (WP) of the project begins with a focus on consumers and food environments so as to better "guide" or inspire the valorisation process along the whole NUC value chain. Its work is founded on the assumption that there is a knowledge (and practice) gap with respect to the mechanisms, networks and physical infrastructure (i.e., food environments (Downs et al, 2020)) which link the production and consumption ends of the value chain. It is for this reason that one of the objectives of WP1 is to better understand how to influence both "engaged" and "regular" consumers in the valuing of agrobiodiversity, and what role the food retail environment plays in this respect.

Task 1.2, in particular, focuses on analysing NUCs-based products' value in food environments by drawing on an extensive collection of primary data in the 7 countries involved in the DIVINFOOD project. As a background for that investigation, this document will review what is already known about food retail environments that value agrobiodiversity and NUCs in particular.

1.3 Research questions and methodology for the literature review

Given the above, the literature review focuses on 3 key questions:

- What does the literature on food environments tell us about the influence that the food retail environment has on what consumers will buy and consume?
- How can these insights be adjusted to better understand how food retail environments can make NUCs more “appealing”?
- Do retail outlets in Europe valorise NUCs?

In order to answer the above questions, this review focuses on:

1) sourcing the latest scientific literature on the food retail environment, and
2) sourcing scientific reports on how NUCs are commercialised in the 7 countries that form part of the DIVINFOOD project.

A systematic literature review was conducted in order to find the relevant scientific literature. This review was carried out in two steps. For the first step, the results were collected from a prior similar review on food environments which was carried out by the first author (Mattioni et al., 2020; Mattioni, 2021). These were complemented by updating the original list with relevant publications published in the last 3 years.

For the second step, we used the following keywords linked to each of the 7 countries to identify relevant literature in the Web of Science and SCOPUS databases:

TITLE-ABS-KEY ("neglected crops" OR "underutilised crops" OR "minor crops" OR "landraces").

As many of the searches produced a majority of articles that focus on the genetic traits of NUCs, we limited the search to journals that belonged to the social sciences, environmental sciences or agricultural and biological sciences. Overall, we retrieved 238 documents. A review of the abstracts was carried out which concluded that only a small minority of the articles (27) dealt with aspects related to the commercialisation of NUCs. The rest were either inventories of NUCs or focused on aspects related to the agronomic/genetic/nutritional traits of the NUCs.

2. Results

Review of current literature on food retail environments and what the scientific literature says about how they currently valorise NUCs.

2.1 Overview of the Food Environment literature: concepts and evidence

2.1.1 Food systems and the food environment

In spite of the many advances made in terms of reducing malnutrition worldwide, the constant rise of diet-related non-communicable diseases (NCDs) witnessed in the past decades has highlighted the importance of shifting towards healthy and sustainable diets, i.e., diets that contain more fresh fruits and vegetables, legumes and wholegrains, and less refined carbohydrates, sugars, certain types of meat and animal fats and ultra-processed foods (Willett et al, 2019). In Europe, the situation mirrors that of global trends: NCDs in Europe account for 90% of all deaths, and in 2017 more than 50% of the adult population in the European Union (EU) were overweight, of which 15% were obese (EUROSTAT, 2022). Here, too, diet is a major contributing factor, with EU citizens consuming too many foods high in saturated fats, sugar and/or salt (HFSS) and too few fresh fruits, vegetables and legumes (GBD, 2019). While problems of overweight and obesity have repeatedly been framed in terms of "personal responsibilities", the role of environmental and structural drivers in shaping people's eating habits – commonly referred to as the food environment - are now widely recognised and acknowledged (IPES-Food, 2017; Glopan, 2016; HLPE, 2017; EUFPC, 2021), implying a strong role for government and policy intervention.

The food environment has been defined as "the physical, economic, political and socio-cultural context in which consumers engage with the food system to make their decisions about acquiring, preparing and consuming food" (HLPE, 2017): as such its critical role lies in the fact that it "contains the total scope of options within which consumers make decisions about which foods to acquire and consume" (Downs et al, 2020). Food environments are made up of various "pillars", such as the relative price of foods, the quality of the food sold in schools and other public venues (public procurement), food composition, food promotion and marketing, labelling and food retailing: ultimately, **they determine which foods are available, affordable and desirable to people in their surroundings** (Swinburn et al., 2011; EUFPC, 2021). While never formally acknowledged by European institutions, in its recently developed Farm to Fork Strategy (2020), the EU has made progress by referring to the creation of an enabling food environment, i.e., an environment that makes it easier to choose healthy and sustainable diets (EU, 2020).

Importantly, the food environment is the outcome of, and at the same time influences, the underlying food system it rests upon (HLPE, 2017). Food systems can be thought of as four sub-systems that make up the whole food chain "from field to fork": agricultural production (primary production of food and related inputs); food storage and distribution (all those activities that take place post-farm gate, such as food handling and transportation); food transformation and packaging (mainly concerned with processing and packaging); and food retail (which includes wholesalers and markets). As each of the subsystems influences the food environment, this

highlights the need to intervene at different levels of the food chain to modify food environments (Fanzo et al., 2020).

2.1.2 The food retail environment

Given the focus of this deliverable on the retail stage of the food system, this sub-section section will provide an overview of the latest evidence on one of the pillars of the food environment, that is, the food retail environment (FRE) and more importantly, on the methods used to measure it. The analysis of the FRE can be subdivided into two distinct areas of work: *community food environment* studies, that look at the density and proximity of different types of food outlets in neighbourhoods, and *consumer food environment* studies that focus on what consumers find once they walk into shops (or restaurants) (Ni Mhurchu et al, 2013). A review of the literature on the relationship between both the community and the consumer food environment on the one hand, and dietary patterns (and/or health outcomes) on the other, shows that certain variables are more robustly correlated to unhealthy dietary patterns and/or levels of overweight and obesity. Experimental studies on the community food environment show that the relative density of healthy/unhealthy outlets has a higher positive association (albeit mild) with dietary patterns and outcomes than proximity (Caspi et al, 2012; Burgoine et al, 2018). In other words, what matters most for dietary patterns is not so much how close one lives or works to an "unhealthy" outlet (such as fast foods and convenience stores), but the relative number of these outlets compared to healthier ones, such as shops selling fresh fruits and vegetables.

On the consumer food environment, evidence shows that the way food is displayed and promoted within a grocery store or a supermarket has an influence on what types of food items consumers will choose to buy. For example, studies on the link between diets and shopping at farmers' markets, community supported agriculture (CSA) and other local food initiatives, have shown a positive correlation between shopping in these outlets and an increased intake of fresh fruits and vegetables as well as a more positive attitude towards healthy eating (Pitts et al, 2013; Minaker et al, 2016), while the way that different categories of foods are sold in supermarkets, i.e. there is generally a higher prevalence of processed and ultra-processed foods sold compared to fresh fruits and vegetables, can lead to choices that do not support healthy diets (Demmler et al, 2018).

It is important to note that the consumer food environment also includes *out-of-home consumption.* While eating out used to be a special and infrequent activity, today it has become far more normalised, with people using circa 40% of their food budget on eating out (US Bureau of Statistics, 2018; Eurostat, 2022). Here, too, there is evidence on the link between eating out and dietary patterns: the more people eat out, the greater the odds of an increased total energy and fat intake compared to when they eat at home, with fast food outlets having the highest correlation with total energy intake compared to restaurants (Nago et al, 2014). This is related to the fact that the types of food sold, and the way food is promoted and displayed on the menu both have an influence on what people choose to buy. Several interventions were made – both as scientific experiments but also as policy measures – to change the food environment in restaurants and "redirect" client choices, such as energy labelling on menus, changing the content of the menu by introducing smaller portion sizes or increasing the proportion of meals on restaurant menus that are lower in energy content, with the latter being more effective in leading to a substantial reduction in energy purchased by consumers than menu labelling (Marteau et al, 2015). Indeed, while energy labelling can be useful as it may be an incentive for outlet owners to reformulate their menus, it has a small impact on the overall energy purchased by consumers (Crockett et al,

2018). Beyond the considerations on impacts on diets, the point here, once again, is on the influence that the way food is made available in restaurants has on client choices.

2.1.3 The digital food environment

A relatively new phenomenon in the realm of food retail environment research that warrants attention is what is currently being called the "digital food environment". These online food shopping forms are varied: pure e-commerce, "brick&click" retail (both online and physical stores), click&collect, home delivery, among others. Data shows that, especially since the beginning of the COVID pandemic, online shopping from supermarkets and other grocery stores has increased in many countries (Khandphur et al, 2020). Given the novelty of the trend, little evidence exists on the influence that digital online retail shopping interfaces have on consumer food behaviour and/or dietary outcomes. A recent systematic review of the existing evidence, however, suggests that "online supermarkets are […] skewed towards promoting unhealthy products and that […] the online environment offers new and more covert methods to further the bias towards the promotion of unhealthy ultra-processed foods" (Maganja et al, 2022). On the other hand, labelling for healthy foods may be put forward to online consumers, and digitalised food delivery or local collecting could mitigate the absence in food deserts of physical shops selling healthy foods. Alternative Food Networks, for example, use digital technologies to build digital-material forms of reconnection which articulate virtual-material reconnections between local food producers and urban food "prosumers" (Stephens & Barbier 2021).

Beyond the implications for diets, what the above shows is that the way in which the food retail environment is "constructed" – both physically and digitally - strongly influences what consumers will buy and consume. This refers both to the way shops are spatially distributed (in a city for example) and to the way food is displayed, promoted and priced inside shops and restaurants.

2.2 Are FREs currently valorising NUCs? Retail spaces dedicated to NUCs in Europe

As the above sub-section highlights, most of the research carried out on FRE in the past 20 years has focused on the influence of FREs on dietary patterns/health outcomes: the study of FE was indeed born within the public health community with an explicit aim to better identify and analyse the structural determinants of health. In doing so, an important contribution was made to better conceptualize the two-way links between consumer behaviour and food systems via the mediation of the FE. The objective of this section is to adjust the FE framework, particularly in relation to the FRE, to the specific objective of DIVINFOOD aimed at valorising Neglected and Underutilised Crops (NUCs). To do so, we moderately redefine (specify) what is meant by an "enabling" food environment.

In the case of DIVINFOOD the aim is that of creating a FRE – both physical and digital - that makes it easier for a consumer to find and choose NUCs, specifically the NUCs that the project focuses on, i.e., legumes and minor cereals.

What do we know today about whether and how FREs in Europe make it easier for consumers to consume NUCs? A review of the 27 articles identified, as mentioned in Section 2.3 and as listed in

the References section, allow us to respond to this question. First, it is important to highlight that due to their very marginalised status, it is generally difficult to find NUCs on the market – which does not make it easy for consumers to recognise or consume NUCs. In the past decades we have globally witnessed a decline in the diversity of crops present in farmers' fields, with only 9 crops today accounting for 66% of total crop production (FAO, 2019). Europe has been no stranger to this trend (Raggi et al, 2022). In Italy, for example, there has been a genetic erosion of about 70% of landraces in Southern Italy over a period of thirty years (Vetelainen et al, 2009), while in Hungary, of the 4.500 landraces of Phaseolus vulgaris stored in the Hungarian National Biodiversity and Gene Conservation Centre, only very few cultivars are used (Ministry of Environment, 2009). Similar considerations can be made for Portugal (Veloso, 2008) and for cereal landraces in Switzerland (Bardsley & Thomas, 2004). France has also witnessed a large loss of cultivated agrobiodiversity, especially for main crops such as small grain cereals (Bonnin et al, 2014), and similar trends have been observed in Scandinavian countries (FAO, 2019).

Considering the above, it may not be surprising that a recent review of the literature shows that there are hardly any studies that comprehensively map consumer and community FREs in relation to NUCs, i.e., that help identify which shops sell NUCs prevalently and how NUCs are displayed within shops. There are however a number of studies that focus on different types of NUCs and countries that show that NUCs are sold (when not used for own consumption) using a variety of commercialisation channels (Chable et al, 2020; Raggi et al, 2021). Due to their marginalised nature and link to specific localities (Raggi et al, 2022), NUCs tend to be sold via **direct sale or through short food supply chains (SFSC)** where local intermediaries/processors such as mills, bakeries, breweries and pasta-makers play a key role. A recent study carried out in Europe based on an analysis of 95 landrace value chains confirms the above, specifying that landrace products are mainly commercialised in local markets (58.9%) and, to a smaller extent, at national level (23.3%), while a lower but significant portion is cultivated by gardeners or farmers for personal consumption (14.4%) (Raggi et al, 2021).

The world of SFSC is quite differentiated, however, and in order to better understand the role which NUCs currently play and could in the future, it is useful to closely analyse what they currently look like in different countries. A recent overview of the literature on the ways in which SFSC chains have developed within and across Europe shows that different types of these chains prevail in some countries when compared to others (Chiffoleau & Dourian, 2020). With respect to the DIVINFOOD countries, the study shows that in France, Italy and Portugal, Farmers Markets (FMs) developed alongside the more traditional open-air markets where we find not only producers but also intermediaries, while in Hungary, FMs and consumer-driven initiatives (particularly Community-Supported Agriculture) exist alongside substantive non-market-based self-provisioning practices (e.g., private lots/gardens) (Vavra et al, 2018). In Denmark and Sweden, the recent emergence of the "New Nordic Cuisine", has seen the emergence of a "specialty food" movement that relies on local supply networks (Manniche & Saether, 2018).

In addition to having a better view of which types of retailing outlets make up SFSCs in different countries, understanding how 'quality' is communicated and assured within these SFSCs is key considering the importance that consumers place on a number of sustainability quality attributions (e.g., organic, local, healthy, agro-ecological, traditional, etc.), often close to agrobiodiversity, and the role that intermediaries play in chains that valorise NUCs. A recent survey on how quality is communicated in SFSC across the EU member countries suggests three types of SFSC quality assurance: farm focused - driven mostly by producers with a focus on direct

sales -, market quality – driven mainly by intermediaries who assure the quality of the products themselves -, and collective quality – led by producer-intermediaries often using third party certifications (Loconto & Garrido-Garza, 2021). Data from this survey highlights the key role of the intermediary in mitigating problems such as fraud and lack of trust.

Case studies on how NUCs are commercialised in SFSC highlight the different types of SFSCs where NUCs are sold, and the role of certain intermediaries/processors in making it easier to circulate awareness around NUCs to the wider public. In Italy, the latter has been the case for minor cereals in Calabria for example, where there is a close connection between producers and processors (Vitale & Sivini, 2018), or for the beaked maize varieties of Northern Italy. A growing interest by consumers in traditional food products and their higher sensorial value has led to their revival since the 1990s. Data shows that they are typically sold directly by farms to the public (sometimes with the aid of a website or a social media page) or, in some cases, to restaurants, mills and grocery stores (Ardenghi et al, 2018; Fenzi & Couix, 2022). In France, we see similar processes in the case of certain livestock breeds that risk extinction: some farmers here have opted for selling their meat directly to the local butcheries or to sell their products directly on the farm (Verrier et al, 2021). The same is true for ancient varieties of tomatoes in the Languedoc-Roussillon region that are either sold on-farm or in local open-air markets (Bellec-Gauche et al, 2015), and for landrace cereals in Sweden that are sold on-farm, in FMs, to processors/intermediaries (such as mills or bakers) or through consumer-driven initiatives (Ortman et al, 2023). In Portugal, ancient maize varieties are used to make the typical central and northern bread called "broa", hence the maize is sold by the farmers to the mills (Vaz Patto et al, 2007). In Hungary, most of the identified NUCs are cultivated in home gardens, prevalently for own consumption, even though some small quantities may be sold in local markets (Birol et al, 2006).

In Italy, a number of cases show that landraces of various species are used partly for own consumption but also sold on local markets (Piergiovanni et al, 1999; Negri, 2003; Conversa et al, 2020; Montesano et al, 2012). An interesting case is the role of tourists, as in the case of vegetable landraces in Puglia (Italy) sold mainly through local markets in the summer months at the peak of the **tourist** season in the area (Conversa et al, 2020) or in Basilicata where they are sold either in local markets or in "agritourist" resorts (Montesano et al, 2012). A recent app – Agrobioversiapp - developed by the Regional Agency for the Development and the Innovation of Lazio Agriculture (ARSIAL) in Central Italy shows that a number of landraces are used in restaurants of "agritourist" resorts found in the rural areas around Rome.

NUCs can also be found in large **supermarkets**. This is because in the last decades or so, supermarkets and hypermarkets have begun to offer products directly from the producers (Loiseau et al, 2020). Case studies carried out in 3 different regions of Italy show that minor cereals are commercialised through a mix of retailers, such as local restaurants and local pizza and pastry shops, but also large supermarkets that have a dedicated space for "territorial products" (Loizzo, 2022).[1] Another way through which NUCs enter supermarkets is through EU geographical indications (GI) labelling or other voluntary labels. A study carried out in Italy on the sale of PDO products shows that, in the case of horticulture and cereals, half of the products are sold in supermarkets (Arfini et al, 2010).

[1] This study is particularly pertinent for the research conducted by DIVINFOOD, which will be presented in D1.4. We will use Loizzo's typology of value chains as a point of comparison for what we have found in our empirical research.

In fact, one route for increasing the sale and use of landrace products – especially in Southern Europe - is through **EU geographical indications labelling**. A recent study on GI horticulture products (including legumes) in Europe shows that more than half of the PDO (Protected Denomination of Origin) products concern landraces, and that the fact of having this label allows a greater commercialisation of the product especially at national and sub-national levels (del Castillo et al, 2021). The above-mentioned study carried out in Italy on the sale of PDO products gives us an idea of where these products can be found by consumers (Arfini et al, 2010). The study specifies that PDOs are sold through a diversity of retailers: in the case of horticulture and cereals, half of the products are sold in supermarkets, about a quarter are sold through direct sale, followed by products sold in local markets/traditional food shops and lastly, about 10% are sold in restaurants. While not all horticulture and cereal PDOs examined were related to landraces, considering that about half of all horticulture PDOs in Europe concern landraces, we can assume that in Italy horticulture and cereal NUCs can be found in a diversity of retailers.

A recent study however noted that in many cases NUCs are not commercialised using a geographical indication to promote landrace products on the market; they do however use **other types of commercial indications or brands such as 'Slow Food Presidium', 'Green heritage' and 'Pro Specie Rara'** (Raggi et al, 2021), and this allows farmers to obtain a higher price for their products, such as in the case of the Fagiolina of Trasimeno Lake (a cowpea landrace of Central Italy) that has become a slow food Presidium and is sold in gourmet restaurants (Negri, 2009), or beer and whiskey in Scotland made from *bere* barley, a landrace of the Orkney Islands, which is traditionally associated with the area and is marketed based on its "viking" identity (Vetelainen et al, 2009). Similar ideas that have emerged concern the creation of niche markets for non-food animal products, such as garments made from the wool of sheep landraces in Italy (Sardaro & La Sala, 2021). In terms of arrangements for quality assurance – intended as a joint and consensual definition of what defines quality -, there is evidence of quality assurance led by farmers cooperatives jointly with processors, such as the case of the Consortium of the Quarantina potato for a landrace in the North-west of Italy (Lamine et al, 2019), the Consortium for the Protection of Marano maize in the North-east of Italy (Fenzi & Couix, 2022), and the association "La bastinaca di San Vito" for a carrot landrace in Southern Italy that has obtained the Slow Food seal (Renna et al, 2018).

With respect to **out-of-home consumption**, there is very little information in the considered literature on the role restaurants play in giving value to NUCs. There are examples of gourmet restaurants that can play this role and often use agrobiodiverse products not only to differentiate themselves but also to contribute to the conservation of NUCs (Luziatelli et al, 2020; Pereira et al, 2019). In addition to gourmet restaurants, there is a growing literature on sustainable restaurants and logos associated with them (Higgins-Desbiolles et al, 2019). Examples include the Green Key certification in the Netherlands, the Food Made Good label of the Sustainable Restaurant Association (SRA) in the UK, or the Green Dining logo in the USA of the Green Restaurant Association. In all cases, key criteria to measure the extent to which restaurants are promoting "sustainable food" include sourcing locally and seasonally, using food grown organically (or using other climate-friendly methods), protecting animal welfare, and using sustainably sourced fish and fair-trade products. Very few criteria however exist to valorise NUCs.

2.3 Discussion about 'enabling vs constraining' food environments – the basis of an analytical framework

2.3.1 Focusing on the Consumer Food Environment

2.3.1.1 4 Ps - the way NUCs are displayed, promoted and priced

The above overview shows that there is some systematic knowledge in the literature about how NUCs are currently commercialised in Europe. There is however very little knowledge as to how NUCs are valorised in-store, except for the use of labels: this is important considering the influence that the way food "appears" and is communicated in-store or in a restaurant has an effect on consumer purchasing patterns as we have seen in Section 2.1.

Most of the research carried out in the consumer food environment has focused on types of food products sold in outlets and their relative prices, and calls have been made to complement existing instruments that focus on food products and relative prices, with data on how products are placed on the shelves to make them more or less attractive, and the promotional materials used in outlets to steer choices (Kelly et al, 2011; Dubowitz et al, 2015). This has led to an integration of the '4 Ps framework' (product, price, placement and promotion) widely used by marketing specialists in the checklists currently used to measure the consumer food environment, of which an example is the INFORMAS food retail protocol that uses criteria related to shelf-space, placement, and promotion to monitor the availability of healthy and unhealthy foods in consumer retail environment (University of Auckland, 2017). Other widely used tools include the NEMS-S and the NEMS-R, the Nutrition Environment Measures Survey tool used respectively for stores and restaurants. The measures in the NEMS-S focus on availability of more healthful or recommended choices, quality of fresh vegetables and fruits (i.e. whether they are bruised, old looking, overripe, or spotted), and prices (absolute and relative to their "unhealthier" counterpart) (Glanz et al, 2007). Both in the INFORMAS and the NEMS-S protocols the measures and variables are assessed by direct observation.

Considering the nature of the DIVINFOOD project and its focus on food retail environments for NUCs rather than for healthy vs. unhealthy food items, the measures developed by the INFORMAS and the NEMS tools need to be adjusted. Below is a proposed set of variables – to be used for the development of D1.4 – drawing from the 4Ps of marketing aimed at measuring the extent to which NUCs are made more or less "appealing" in-store (Table 1).

Based on the data analysed in Section 3.2 on the venues where NUCs are prevalently sold today, it is important to note that by "retail outlet" what is meant here is shops, supermarkets, farmers' markets, consumer-driven initiatives (box delivery schemes for example) and on-farm sales.

Variables/measures	*What is being measured?*	*How to measure?*
Availability of **product** (in lieu of shelf space, because NUCs will not be very present in shops)	Is the NUC present in the retail outlet? Is the NUC sold online? Question for "pure e-commerce" retailers (i.e., with no physical shop): is the NUC	Number of NUCs/total n. of products of the same category (e.g., legumes)

	present in the list of available products?	
Placement	Is it placed in a visible area of the retail outlet? Online sales: is it easily found on the website? is there a separate and dedicated section in the online shop?	For supermarkets, high-visibility areas are aisle caps or next-to-cashier spots. For other retail outlets, it will be up to the data collector to assess level of visibility based on the overall retail context.
Promotion	-To what extent is it promoted through posters, leaflets and other means, e.g. special discounts or coupons? -To what extent is it promoted through brands/labels? -Online shops: to what extent is it promoted through online messages/promotional material?	-Number of NUCs info material/total n. of info material of the same category (e.g. legumes) – this measure is valid both for physical outlets and for online shops. -Number of NUC products with a brand/label
Price	-Absolute price -Relative price	-Price of the NUC to be compared with similar NUC in other shops -Price of the NUC compared to products of the same category (e.g., legumes)

Table 1. Proposed food retail environment measures for DIVINFOOD NUCs (adapted from University of Auckland, 2017 and Glanz et al, 2007)

The above information would ideally be collected via direct observation in-store. It may be complemented by qualitative data collected through key informants, such as store owners, or observation in-store, aimed at better understanding if the information provided orally by the store owners of shop assistants helps communicate the value of NUCs. In the operationalisation of this analytical framework for the empirical data collection carried out under Task1.2, we have adapted these on-site observations into specific, multiple-choice questions in the online questionnaire that was sent out to roughly 1200 FRE actors in the 7 partner countries (see D1.4 for detailed information).

2.3.1.2 Diversity and trends across countries, products, types of environments

Based on the above literature review, currently there are very few factors in the food environment that enable the purchase and consumption of NUCs in Europe or in the 7 countries where the DIVINFOOD project is taking place. The caveat to this statement is that there is very little data, neither qualitative and quantitative, that has been published to date in the scientific literature which has been considered. Therefore, not enough is known to be able to give a definitive "shape" to the FRE for NUCs. This result serves only to further justify the importance and originality of the empirical research being carried out within DIVINFOOD.

Nonetheless, and despite its limitations, we can begin to sketch out some trends based on the currently available data.

In terms of *community* FRE, and based on overall retail revenues, the retail outlets that sell most of the food available to consumers today in all DIVINFOOD countries are **supermarkets** (Van Dam et al, 2021; Global Data, 2023). However, NUCs seem to be present in very small quantities, and their price is higher due to the use of GI (especially in south Europe) or other labels that rely on price premiums. NUCs seem to be more available in SFSC, which currently represents a retail channel where a minority of people buy their foods. It is worth noting however that in countries such as France, Italy, Portugal and, to some extent, Hungary, where local open-air markets are more widely used (although we do not have data on the quantities of NUCs sold therein) there are likely more people involved in SFSCs.

In terms of **out-of-home consumption**, the limited data that exists tells us that NUCs are mainly available in gourmet restaurants which constitute only a small minority of restaurants that consumers use. Factors that do enable a greater availability of NUCs however relate to the presence of processors/intermediaries that are interested in NUCs for various reasons (for which we do not have details), such as mills, restaurants, bakeries, pasta-makers, breweries and others.[2] While this may lead to an increase in the final price of the product for the consumer compared to a direct producer-consumer sale, they do seem to play a role in making the product more available and desirable insofar as it is "packaged" or processed in a way that appeals more to consumers. For example, it is processed in a more "ready-to-use" product such as bread, beer or a restaurant item.

In terms of *consumer* food environment, some conclusions can also be drawn based on existing data. As mentioned above, **labels** make it easier for NUCs to be present in certain outlets, such as GI labels in supermarkets, although not all GI products signal the presence of NUCs. In addition, GI brands are used primarily in countries in the south of Europe, which means that, in terms of DIVINFOOD countries, they are more relevant in Italy, France and Portugal. Brands and voluntary labels have also been used to increase the availability and desirability of NUCs, although their implication in terms of final price limits their purchase and consumption. In terms of out-of-home consumption there is very little data to tell us the extent to which NUCs are available in restaurants, but what is available points to very small quantities and largely only made available in gourmet restaurants that cater to higher income consumers, especially in cities. There is some data in Italy and Hungary, around restaurants or "agritourist" resorts in rural areas where NUCs are more easily available.

[2] From this literature review, it is clear that more data is needed in order to clarify the role of processors and intermediaries in the NUCs value chains. We will explore this more in D1.4.

3. Conclusion

3.1 What insights does this information provide regarding enabling food environments for NUCs?

As we have defined above, an enabling food environment is one that makes NUCs more available, affordable and desirable to people in their surroundings. This is because, to answer Research Question 1, the FRE has a strong influence on individual purchase and consumption patterns. From the information gathered and analysed above – despite its limitations – we can say that at present both the community and the consumer FREs do not make it easy for a consumer to find and choose NUCs. This is especially true for citizens belonging to lower income groups or those not part of a SFSC. So, in relation to Research Question 3, at present, retail spaces in Europe do not valorize NUCs.

To answer Research Question 2, the way in which the FRE can make NUCs more "appealing", specifically the NUCs that the project focuses on, i.e., legumes and minor cereals is twofold. In terms of the community FRE, the amount of retail outlets that sell NUCs needs to increase (i.e. the P of product availability).[3] Specifically, NUCs should ideally be present in all types of retail outlets – both shops and out-of-home consumption outlets. They should also be more present digitally – in pure e-commerce sales, in "brick & click" retail (both online and physical stores), in "click & collect", and home delivery. In terms of consumer FRE, the amount of NUCs within outlets and their visibility (the P of placement) therein would also have to increase. Specifically, there should be a greater number of NUCs – whether raw or processed – present in all retail outlets and they should be better promoted, whether through posters, leaflets, or other initiatives (the P of promotion). Ideally, price differences with non-NUC similar products would not to be too high. Another important part of the FRE that would help make it more favourable to the consumption of NUCs is the greater presence of NUCs in restaurant menus – not just gourmet menus, but those accessible to a wider portion of the population.

3.2 What type of information do we need to collect in order to better understand how agrobiodiversity-based products are valued in the food environment?

There are a number of research gaps in this area of work that emerge from the above. More needs to be known about how NUCs are commercialised and sold at retail point to have a better idea of how to construct more favourable FREs for NUC purchase and consumption. In terms of the community FRE, it would be useful to collect more detailed and aggregate information as to which outlets – both physical and digital – sell NUCs, and the relative presence of NUCs therein. An interesting piece of information that has emerged from this literature review is the role of processors/intermediaries and of rural agro-tourist resorts. These would have to be included as outlets that are not usually included in "classic" FRE research. More information is also needed on

[3] In this literature review we did not find reliable statistics about the market shares of NUCs. We introduced some collection of national level statistics into the work of Task 1.2 and these results will be presented in D1.4.

the consumer FRE, and the type of information that needs to be collected to that end has been highlighted in Table 1. What is missing there, in light of the key role that some processors/intermediaries have in communicating the value of NUCs, is a quali-quantitative analysis of the tools used to do so.

These last two areas of research will be further explored under Deliverable 1.4.

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