# LEGATO

## LEGumes for the Agriculture of TOmorrow

**Collaborative project**
**Grant agreement no: 613551**
**SEVENTH FRAMEWORK PROGRAMME**

**THEME [KBBE.2013.1.2-02]**
**[Legume breeding and management for sustainable agriculture as well as protein supply for food and feed]**

# Deliverable D4.1

## *Literature review and inventory: Consumer behaviour in relation to novel uses of legumes*

**Due date:** M6

**Actual submission date:** M11

**Project start date:** 1st January 2014 **Duration:** 48 months

**Workpackage concerned:** 4

**Concerned workpackage leader:** 1

**Concerned task leader:** JB Traversac INRA in collaboration with A. Seabra-Pinto ISA Lisbon

**Dissemination level:** PU (public)

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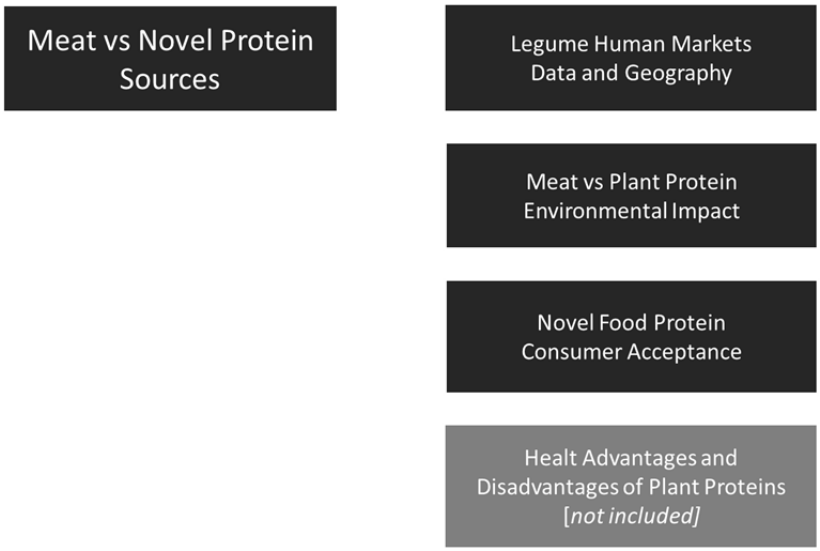
## INTRODUCTION

In this report we will put in evidence the principal aspects that have been considered in the consumer behavior literature in relation to novel protein food. There is an incredible paradox on the relatively low level of Legume / Pulse use compared to their social benefits. Legumes are an interesting solution to malnutrition considering their cost and their environmental externalities. This document presents the results of a bibliographic analysis on the plant protein consumption. We chose a wide examination of consumer studies on the subject of Novel Food, intended as Novel Protein Food, to perform our research. Whereas the diverse legumes in all their diversity of variety, forms, and cooking presentation are not exactly new food components, their limited place in food regime demonstrates the need for innovations in their use as ingredients. The following presentation resumes current knowledge related to legume consumption as alternatives to meat products.

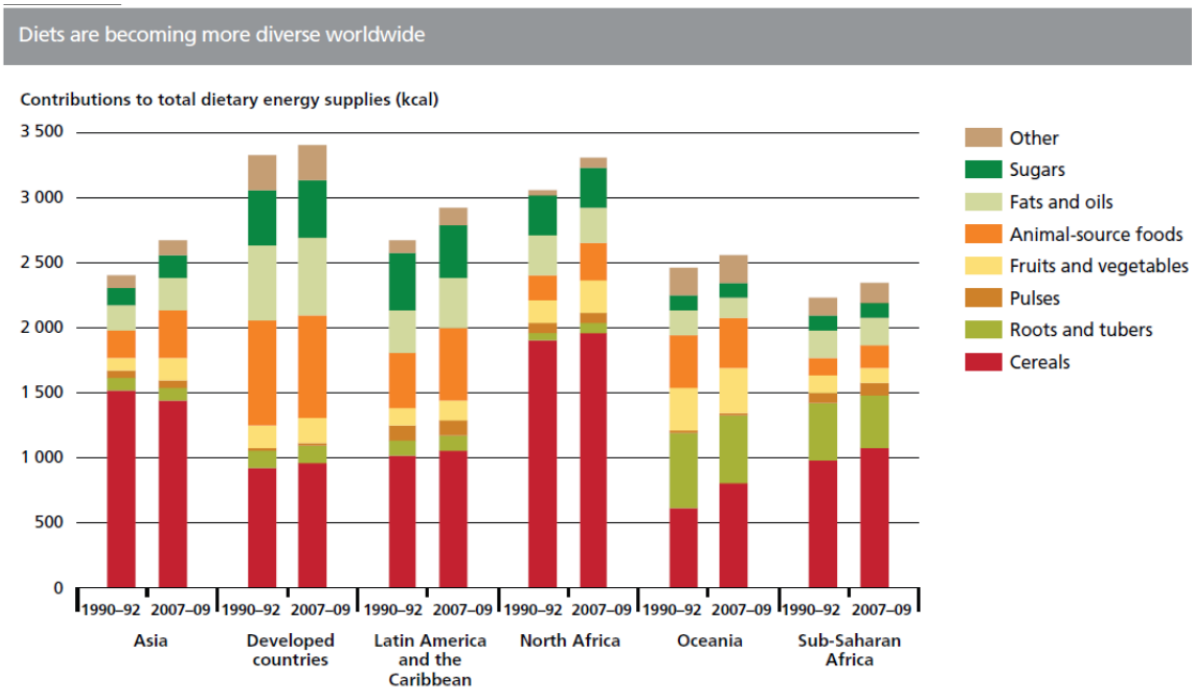



**CORPUS ON NOVEL PROTEIN FOODS**

This report began with some data on the importance of pulse consumption to the global food and nutrition security and how the aspects such as cultural and geographical localization impinge on the discussion about the future of plant protein in food security (part 1). We then introduce the current debate on meat consumption and its actual or potential substitutes. An important debate started when meat consumption and its consequences for the earth and human beings – environmental, health and nutrition - were put in question. Researchers and NGO have investigated the trade-off between animal and vegetable proteins and the consequences of meat substitution for the earth's future (part 2). This trade-off is the major driver for a renewal of the political consideration of legumes in Europe and in other parts of the world, in the OECD as well as in developing countries. We follow with the central question of our task: How does consumer appreciate and judge the intrinsic and extrinsic characteristics of legumes? Do consumers and citizens react to the debate on the future of the food security regime through the consumption of legumes? The last part of this document presents some studies that analyze consumer behavior faced with different sources of protein (part 3).

# 1. GRAIN LEGUMES: GEOGRAPHICAL DISTRIBUTION AND CULTURAL IMPORTANCE

According to the data provided by FAO, Legume consumption is unequally distributed in the world and between populations. In Europe legumes are associated with rural heritage and ethnic foods reflecting the image of consumers localized or originating from Southern countries. Beyond this representation as "Food of the Past", legumes hold a substantial potential for feeding future generations. In a world with a dramatic increase in its population Novel Protein Food would be the major sustainable path for ensuring food security[1].




SOURCE: FAO 2012

Legume dishes area traditional component of the food culture in Mediterranean, Latin American, East Indian, and Middle Eastern countries. This has largely been due to the high cost and limited availability of meat in these countries (CANGLOBAL 2001).

[1] United Nations, Department of Economic and Social Affairs, Population Division (2014). World Population Prospects: The 2012 Revision, Methodology of the United Nations Population Estimates and Projections. ESA/P/WP.235.

Heterogeneity in legume consumption appears also at a regional level. In Europe there are significant differences between, on the one hand, countries with large supplies of protein provided by vegetables and cereals, and, on the other hand, countries with large supplies of protein derived from meat and milk. In this respect, Portugal, Italy and Greece can be contrasted with the Netherlands, Sweden and Finland as the two poles of an axis, with intermediate positions for the other countries or regions. France as example being divided between the butter and the olive oil/legume regions. A number of interrelated differences between these countries/regions clearly demonstrate the impacts of ecological, economic and cultural factors on current dietary protein supply. In northern countries, when compared to meat, legumes are perceived as a low cost protein alternative, preferred by immigrant and low income households.

Nevertheless, legumes are not totally excluded from northern countries' diets. The example of Canada reveals the presence of legumes in developed countries food regime in significant quantities. Ipsos has analysed the factors influencing Legume (pulse) consumption in Canada (Ipsos 2010). Present in the panel of ingredients of a majority of person surveyed, legumes are however not a major constituent of the Canadian diet[2].

> "*One-in-five Canadians report they have not consumed any pulses in the past six months. Overall, two-in-three (66%) Canadian adults indicate they have consumed beans in the past six months. This drops to just over half with regard to chickpeas (53%) and peas (52%), while consumption of lentils is limited to four-in-ten (41%) Canadians" p.1 …. "Overall, two-in-three (66%) Canadian adults indicate they have consumed beans – at home and/or at a restaurant – in the past six months. This drops to just over half with regard to chickpeas (53%) and peas (52%), while consumption of lentils is limited to four-in-ten (41%) Canadians. Four-in-ten (39%) Canadians' pulse consumption is limited to their home only…" p.5 (Ipsos, 2010)*

[2] The real importance of Legume is hidden by their absence as specific constituent in the statistical databases.

In EU, the most important group of pulses/legumes is dry beans[3], hereafter denominated pulse[4]. Human consumption of pulses decreased during the recent period in most countries. Pulse are associated with difficulties in digestion, off-flavoursand therefore reluctance to consume (FAO .2012).

In terms of trade, the EU is a net importer of pulses/legumes, due to an insufficient domestic production, despite the absence of competition with soy. France, the United Kingdom, Spain and Germany are the leading producers of the principal pulse crops, peas, broad and horse beans. Despite a stable demand, peas and lentils are hardly cultivated in the EU and are mainly imported. In 2008, the EU imported 21 million € / 1.5 million tons of pulses (mainly peas for animal feeding). Due to concentration of the major firms involved in the commodity markets, trade channels for pulses/legumes are basically the same for all European countries. Trade goes mainly through commodity traders. In the Southern countries, sales agents and SMEs are more frequent. Most pulses are used in the animal feed industry.

A voluntary politics of subsidy by the French government increased pulse production during the 2008 campaign, unfortunately the production decreased as soon as the level of national subsidies for legumes was reduced (Cavailhes 2009). Legumes have importantand valuable assets, in regard to their agronomic properties (Meynard *et al* 2011, 2014), their cost, as well as their health benefits.

> *"Being a source of protein and increasing fibre intake are also important, though relatively lower on the scale. It is notable, however, that being a less expensive protein is not a top factor, nor are digestive considerations. Also, compared to the importance of protein and fibre, the low fat content of pulses is a relatively less important factor."* p.2 (FAO 2010)

The best opportunities on the EU market exist for exports to developing countries. Some of the products, which could profit from current trends, are organically and Fair Trade certified products, GMO-free products and processed or niche products.

[3] Urad and mung beans, adzuki beans, kidney beans and other Phaseolus and Vigna beans
[4] Pulses are the edible dry mature seeds of leguminous crops, excluding those harvested for fresh products which are classified as vegetables (FAO, 2010)

Whereas Eurostat data on EU pulses consumption is incomplete, FAOSTAT data are complete, but unfortunately the most recent data are from 2004. In that year, the leading pulse-consuming EU markets were by far Italy and Spain, together accounting for approximately 60% of EU consumption in 2004. Other main consumers of pulses in the EU are the United Kingdom, Poland and Romania. In the case of Poland and Romania, consumption of pulses decreased during the review period. Furthermore, France saw a considerable decrease in pulse consumption, of 24% annually during the review period. In general, pulse consumption in most EU countries decreased. This process could be the result of the declining consumer interest. (CBI, 2010)

At the world scale, the market for pulses is divided into two segments: human consumption and animal feed. The largest share is for human consumption (2/3) versus a much smaller share for animal feed. Developing countries account for the bulk of total pulse utilization (3/4). Middle East and North Africa are important consumers on the pulse market. A different picture exists in the European market, where the use of pulses is mainly for animal feed (2/3). While pulses are currently mainly sold in consumer packing at the retail trade, they are more and more used as bread fortifiers and in prepared foods. Beans are often used in exotic dishes, such as in Mexican cuisine. They are also increasingly used as a source of products such as protein, flour, starch, and fibre. These ingredients are then used in baked goods, baking mixes, soup mixes, breakfast cereals, processed meats, health foods, pastas and purees.

## 2. 2. MEAT VS PLANT PROTEIN: ADVANTAGE MEAT

The discussion on protein security focuses in recent years on the confrontation Animal versus Plant Proteins after decades of politics effectively promoting an increase in the supply of white and red meats. With the dramatic increase of the world population, this debate becomes more and more acute (FAO 2012, p. 18). It is clear now that the Earth's resources are insufficient to provide enough animal protein for the world's population. The inefficient way to produce protein by the animal conversion of plant protein into animal protein is challenged by innovative protein food.

### 2.1 Cost opportunity of the meat proteins regarding alternative sources

Some declare meat consumption unsustainable, considering on one side the needs of future populations and the dramatic demographic increase, and on the other side, stable or decreasing global resources and the fragility of natural resources. Meat production is directly accused of putting ecological resources under pressure (de Boer et al. 2006).

> "*Meat protein production is particularly environment unfriendly, due to an inherently inefficient conversion. On average, 6 kg plant protein is required to yield 1 kg meat protein. Accordingly, direct human consumption of plant proteins is likely to be environmentally more beneficial than indirect consumption via meat. However, the general trend in food markets seems to be the other way around.*" (De Boer et al., 2006)

Whilst the animal supply chain is contested, the future of the alternative protein sources remains unclear.

The environmental impact of meat and animal product consumption has been the topic of diverse investigations in the recent literature revealing direct correlation between the diet and the environmental burden on the planet. Meat-centric meals generate on average nine times higher greenhouse gas emissions than plant-based equivalents. Moreover specific meat-based products such as beef cause 10 to 20 times more environmental impact. An animal-based diet requires 2.5 to 5.0 times the energy inputs,

2 to 3 times the water, 13 times the fertilizer, and 1.4 times the pesticide use per calorie produced compared with a plant-based diet (Shrapnel and Baghurst 2007). Considering the waste of protein when meat is produced, 80–96% of all protein in cereal and leguminous grains fed to animals are not converted to edible protein and fat (Orkow 1990). The animal supply chain appears to be inefficient in converting and producing protein for human consumption when using plant protein in intensive production systems.

Besides the fat problem centered on health consequences and weakly concerned by energy waste in the food chain (despite the importance of fat in the food energy contents) the protein debate is actually on the impact of meat protein on the food ecological footprint, which is greater than for other food components. Vieux and colleagues examined the greenhouse gas effects of reducing the consumption of energy-dense, high-fat, nutrient-poor food stuffs, and found that the food category of edible fats contributed 7% of daily diet-associated greenhouse gas emissions compared to fruit and vegetables at 9%, or meat at 27%. Considering that the French diet sources over 40% of its energy from fat-type products, it can be understood that edible fats do not have a large (nor proportional) environmental impact when compared to fruit, vegetables or meat products (Vieux et al. 2012).

In European the life cycle assessment considering food products is the object of an increasing number of studies. Authors have compared the relatively high meat intake in the typical diet with meat-free scenarios. Vegetarian diets were found to be between 18% and 31% lower in greenhouse gas emissions than the average diet. The environmental impact of vegetarian diets varies greatly according to the individual type and production method (Roy et al. 2009, Crews TE. and Peoples MB. 2004). In comparison of contrasted diets, diets high in plant or high in animal-based foods greenhouse gas emissions due to diets high in vegetables and fruit are lower than diets high in animal-based foods. Marlow et al. (2009) reported that vegetarian diets are more environmentally friendly than other dietary patterns. Nevertheless, they mentioned that from a food security perspective, vegetarian diet can induce nutritional risks, in term of balance of amino-acid and micronutrient supply. Worrell and Appleby (2000) or Butriss (2013) note that this ecological advantage is counterbalanced by insufficient intake of

certain micronutrients in vegetable diet. This diet is of a monotonous limited selection of nutrient, when even a small animal-based food intake could make a critical difference to micronutrient intake. Thus the advice for a diet high in plant has to be coupled with some meat products. From the food security viewpoint, vegetarian diet is critical.

While the majority of evidence suggests that an increased intake of fruit and vegetables will reduce environmental impact, there is a growing literature that suggests a diet low in meat and high in fruits and vegetables is not always low in environmental impact. This is because the difference in quantity of vegetable substitutes eaten to replace animal proteins can contribute to increase the environmental impacts, due to the increased quantities of cereals and vegetables for human consumption only slightly outweighing the corresponding decline in the resources required for animal feed-cereal. Variability in methods and data can considerably affect the result of GES measures on the impact of feed ingredients (Van Middelaar *et al.* 2013). More have to be done in this question regarding the impact of both type of diet sourced from regions with different land feed bases (e.g. meat from grassland vs meat from cereal-feed base). Methods to calculate the NO3 impact need harmonization and enriched databases for comparative studies.

Reijnders and Soret (2003) evaluate the impact of animal and vegetable protein on the environment considering the whole supply chain. The comparison of meat and processed protein based on soybeans, of cheese varieties made from cow milk and directly from lupine, are favorable to vegetable ingredients. They observe that the environmental burden of vegetarian foods is usually relatively low when production and processing are considered. The environmental comparison on the evaluation of energy inputs and their carbon emission in fish protein and vegetable protein also suggest an advantage for vegetarian food.

> *"In the evaluation of processed protein food based on soybeans and meat protein, a variety of environmental impacts associated with primary production and processing are a factor 4.4-> 100 to the disadvantage of meat. The comparison of cheese varieties gives differences in specific environmental impacts ranging between a factor 5 and 21. And energy use for fish protein may be up to a factor 14 more than for protein of vegetable origin. Assessment suggests that on average the complete life cycle environmental impact*

> *of non-vegetarian meals may be roughly a factor 1.5-2 higher than the effect of vegetarian meals in which meat has been replaced by vegetable protein."* (Reijnders and Soret, 2003)

Technically the lever is mostly feed conversion efficiencies. The efficiency of the transformation of vegetable into animal feed varies between 2.2 and 2.7 kg of feed per kg (Carlsson-Kanyama and Faist 1999). More than the double weight of vegetable may be needed to provide food through animal chain. Generally, fish and broilers are the most efficient feed converters with 1.1-2.6 kg of feed per kg of carcass. Significant feed waste arises due to inefficient protein production systems (subject to differences in nutrient balance).

## 2.2 The Novel Protein Food: For an unlimited extension of resources

In recent years the debate on the protein food security was enriched by the discussion on novel protein sources[5] to complement traditional meat (and vegetable) proteins. New sources with an expectedly huge yield and low production costs appear on the market.

> "*The literature shows a huge potential of diverse protein sources: the soluble and insoluble proteins that exist in agricultural raw materials, the proteins that are obtained from oilseed meals and from several animal by-products; the potential co-production of protein from biofuel production; the promising RuBisCo protein, the major protein component of all green leaves; the proteins extracted from algae, fungus, and insects. Food waste is also considered as a source of protein that appears in different steps of the food supply chain and that could be used in animal feed and human consumption.*" (Boland et al., 2013)

If the huge potential of NPF based on "exotic" sources is expected, the form and the structure of these innovations restrict their entry on the human protein market. To persuade consumers to adopt food from novel protein sources it is clear that consumer education is needed to change behavior (Rothschild 1999) with little to important effort

[5] Boland et al. (2013) consider that novel proteins are "proteins that are not currently used as animal feed, and proteins that are currently used as animal feed modified and improved for human consumption" (p.?).

from the part of the consumer (Van Trijp and Fischer 2011). A change of diet may run into consumer preferences or dislike of specific foods (Boland et al. 2013).

It is known that some meat sources are unacceptable due to religious taboo (Kaci *et al.* 2012), themselves a reaction to sanitary problems. Similarly, innovative protein sources may not be acceptable in some cultures (Grigg 1995). Truly novel protein sources may run into additional dislike by the consumer: insect phobia, a fear of the new, has been shown to be particularly high for foodstuffs (Cox and Evans 2008, Boland et al. 2013). Legal barriers could also hinder the development of some interesting solutions, e.g. a unified and worldwide accepted classification of insect-based food products does not exist yet. The European Novel Food Regulation is still assessing the status of insect-based food products, "tolerating" commercialization in the European market of products in which insects are used as a whole, while forbidding commercialization of processed insect-based products (EC 258/97).

From a consumer acceptance point of view, insect-based products seem to generate even more concerns than other radical food products.

Economists began to investigate the role of information bias on consumer acceptance and WTP for an emerging category of radical food innovation, insect-based products (Pascucci and de-Magistris 2013). Because food products with processed insects are not allowed by European legislators, food firms sell these products using non processed insects and usually having the insects clearly visible on product. In a choice experiment using a sample of 122 Dutch consumers, they showed this is undermining the possibility of business actors to increase the value-added of these products, while increasing the risk of consumers' rejection. An intensive use of positive frames associated to social and environmental benefits of consumption of insect-based foods is not significantly impacting the WTP of interviewed consumers. The negative effects of visualization are difficult to mitigate and represent a serious threat for future success of this marketing strategy.

## 2.3 On the availability of NPF

Note that the presence of plant protein is already noticeable in addition to meat protein. Additions of plant-derived products to animal foodstuffs in the order of 5% of the total fresh mass are already quite common in prepared meals (Smil 2000). Addition of plant protein in traditional as well as modern meals is generally driven by cost and household budget considerations. Vegetable proteins are cheap protein compare to meat protein.

Proteins are not all equally effective in their nutritional characteristics and promoting growth. The quality of a protein is determined by the kind of amino acids it contains and the proportion in which they are present. Good-quality proteins contain all the essential amino acids in proportions necessary for the construction of muscle. Such proteins are known as complete proteins or proteins of high biological value. All animal protein sources are complete proteins, and if eaten in adequate amounts they meet all a person's protein needs. Proteins from vegetable sources, such as beans, contain all the essential amino acids, but generally contain one or more of them in insufficient quantity to meet the needs for growth. Bean proteins are generally rich in lysine, an amino acid often deficient in cereal proteins, and legume proteins are therefore valuable supplements to cereal-based diets. An optimal protein quality can be obtained by combining wheat and chickpea at a ratio of approximately 2:1.

Among the Novel Protein Foods, Legumes are distinguished by their acceptability regarding the rejection of the most radical Novel Food (insect based). Nevertheless meat has still an advantage over the other proteins.

# 3. CONSUMER WILLINGNESS TO ADOPT LEGUMES

The central question of our research is the following one: What do we know about the consumer preference regarding novel protein foods and legumes in particular? Is the consumer ready to pay a premium for the role of NPF on the sustainability of agriculture? Hereafter we present up-to-date analyses on consumer behavior confronted with different sources of protein.

## 3.1 Pulse qualitative studies

Klemcke and colleagues' research, part of the LeGUAN project, aims at establishing how grain legumes are accepted by consumers (Klemcke et al. 2013). They conducted a qualitative study supported by interviews with 103 participants in Berlin and Munich. The interviewees most often described pulses in positive terms. They regard pulses as containing protein and vitamins. They were therefore "good for health". They describe dishes in which pulses are used – *e. g.* lentil or bean soups, stews –as positive in term of organoleptic perception. However, 9% of the interviewees regretted that the preparation was too time demanding – *e.g.* soaking the vegetables during the preparation took too much time.

On the side of negative factors; it appears that the flatulence is not an explanation for the non-willingness to accept pulses. The study result suggests that this problem hardly inhibits the purchase of pulses. Although one-third of the respondents stated that pulses caused them digestive problems, only 14 persons would not consume pulses because they caused flatulence. Of the 20% of interviewees who generally consumed no pulses, the main obstacles to consumption were the taste and the demanding preparation. The favorable association of pulses is much stronger than the unfavorable associations.

The study found that price, freshness, health and ecological aspects were the most important points for the respondents. On the other hand, it was concluded that customers hardly look at product characteristics. Grain legumes are generally accepted to be healthy. For the consumer they are part of a diet diversification, and for this reason are expected to be favorable to health. Surprisingly negative associations such as flatulence are of comparatively little importance. This point has to be questioned

considering the social characteristics of the consumers. To improve grain legume marketing, the authors recommend providing consumers' information to explain the benefits they provide to health and the environment.

To investigate feasible substitution options, Schösler and colleagues presented a variety of meals without meat to subjects (Schösler *et al.* 2012). These meals were rated by the participants in terms of attractiveness and chances that they would prepare a similar meal at home. The results demonstrated the influence of meal formats, product familiarity, cooking skills, preferences for plant-based foods and motivational orientations towards food. In particular, a lack of familiarity and skill hampered the preparation of real vegetarian meals.

## 3.2 Hedonic prices of pea

Surprisingly the economic literature on the price formation at the consumer level and willingness to adopt grain legumes is tiny. Very few studies have been realized on the measurement of the relation between legume characteristics and market prices. The exception is the research conducted by Langyintuo and others (2003, 2004) on the hedonic prices of cowpea in Central-Africa markets. Their data were generated through purchase of samples in seven spatially separated markets, three in Ghana and four in Cameroon, between 1996 and 2000 using similar data collection protocols. During three years, five samples of cowpea were randomly purchased, once per month, in each market. In the market, price and vendor characteristics were noted. In the laboratory, size of grains, color, texture, and damage levels were recorded. The data generated are thus pooled cross-section and time series outcomes with 180 observations per market. The characteristics of the transaction noted are weight of grains purchased per the common unit of measure, usually a bowl in grams, and cowpea grain characteristics, such as grain size, color of the eye, seed coat color, and number of bruchid holes in every 100 grains. The bowl weight is included as an explanatory variable to account for volume discounts. In the markets cowpea grains are sold by volume and hence prices were observed on per bowl basis which were subsequently converted into per kilograms. The estimated regression results indicate that seasonality, grain size, color and insect damage level explain 63 and 97% of price variability in Ghana and Cameroon (Langyintuo 2003, 2004).

In all markets, the grain weight per measuring unit is statistically significant in explaining price variability. Cowpea grain size is statistically significant in five of the seven markets studied[6]. All estimated coefficients on the number of holes have the hypothesized negative sign. Consumers in Ghana and Cameroon seem to differ in their preferences for grain eye color. While consumers in Cameroun discount black-eyed cowpea those in Ghana pay a premium.

The study indicates that quality characteristics are very important in Central Africa food markets for legumes, whereas they are considered as raw materials. Moreover consumers in low income markets are willing to pay a premium for products that match their preferences. They are vigilant in identifying products that do not meet their standards. In the Central Africa cowpea market, the color of the grain is central for consumer (colored vs white grain). The interesting lesson is the change of preference from one market to another. Some prefer black, others prefer white pea.

## 3.3 Genetically Modified Foods

To learn more about GM food preferences products based on vegetable proteins are interesting models due to the importance of soy on the GM markets. Comparable surveys were conducted in different European and Asian countries by McCluskey and colleagues to appreciate the consumer acceptance for GM foods (McCluskey et al. 2003). The surveys solicited respondents' attitudes about food safety and the environment, and perceptions about biotechnology. Respondents were asked about their willingness to pay for the same for GM food as a corresponding non-GM product. In Japan, consumers were asked about GM tofu and noodles, in Norway, consumers were asked about GM bread and about salmon grown with GM feed, in China, consumers were asked about GM rice and GM soy oil.

The results for Japan show that variables representing food safety and environmental attitudes, self-reported knowledge about biotechnology, self-reported risk perceptions of GM-foods, income, and education all significantly increase the necessary discount required for consumers to choose GM foods (McCluskey et al. 2003). The results

[6] To avoid the contemporaneous correlation, the authors used an estimation of all equations jointly with the seemingly unrelated regression estimator, rather than to estimate each one separately using least squares.

indicate that Seikyou (Japanese agricultural cooperative) members, on average, want a 60-percent discount on GM noodles compared to non GM noodles. Increasing self-reported risk perceptions toward GM foods and preferences for domestically produced food both significantly increase the discount required for Norwegian consumers to choose GM foods (Grimsrud et al. 2003).

The results indicate that, on average, the Norwegian consumers in the studies want a 49.5-percent discount on GM bread compared to conventional bread. Interestingly, the estimation results for China present a very different picture (Li et al. 2003). The results show that positive opinions regarding biotechnology significantly increase the premium that Chinese consumers are willing to pay for GM foods. For GM rice, age significantly decreased the consumers' willingness to pay for GM foods. The results indicate that Chinese consumers, on average, were willing to pay a 16.3-percent premium for GM soybean oil over non-GM soybean oil. This is not surprising, given that 23 percent of the survey respondents were very positive about the use of biotechnology in foods and 40 percent of the respondents were somewhat positive about the use of biotechnology in foods. It makes sense that consumers in China, who have low perceived levels of risk (82 percent felt there was little or no risk associated with GM foods) would be willing to pay a premium for GM products.

Chinese consumer attitudes concerning biotechnology may reflect the Chinese government's traditionally strong support. Thus far, the controversy taking place in Europe and Japan is not evident in China, but new regulations regarding labeling and safety testing are most likely leading to increased public awareness of the application of biotechnology to agricultural products.

Japanese and Norwegian cultures both place a great deal of value on tradition. This world-view extends to the food they eat and feed their children. In contrast, the vast majority of the Chinese respondents have positive attitudes toward the use of biotechnology in agriculture and, in general, toward science. Younger people are more willing to purchase the GM Soy products considering that GM is product-enhancing attributes. This result indicates that the Chinese market may be even more open to GM foods than European consumers.

## 3.4 Strategy of meat substitution regarding agriculture sustainability and societal concerns

In order to achieve sustainability objectives, NGO attempt to change citizens' attitudes regarding their protein consumption. Any attempt to address directly the daily behavior of the consumer concerning the problem of the ecological cost of meat consumption considers the amount and the source of protein consumption. These nutritional initiatives to change consumer behaviors provide complementary information on consumer perception concerning a shift on protein sources. One of the strategies that several NGOs are already using to encourage dietary changes is promoting meatless days. This strategy fits into an approach to change decisions at the level of meals. (Laestadius *et al.* 2013). Consumers may respond to it by leaving the meat out of their meal or by replacing it by another source of protein. The strategy of promoting meatless days is mainly an attempt to highlight commitment to a higher order goal.

For the sustainability of agriculture, small changes on protein intakes have positive effects and no direct consequences on diet quality if the change is well oriented in the right substitutes. The study on this issue by Aiking and collegues on Netherlands came to the conclusion that if consumers were to reduce their overall protein intake by about one third, this shift would result in a substantial reduction of the pressure on the environment without putting a healthy nutrition in jeopardy (Aiking et al. 2006). The hypothesis of the neutral consequence on health of the low meat diet is strengthened by the observation that in developed countries on average people consume 60% more protein than the Recommended Daily Intake. One third of the protein supply is meat-based, one third is dairy-based, and one third is plant-based (de Boer et al. 2006). The basic idea of the meatless day is to reduce the level of meat protein intake with or without increase of vegetable proteins.

Other possible strategies to encourage dietary changes are focused on the portion size of meat in each meal. These strategies may promote smaller portions of meat, smaller portions using meat raised in a more sustainable manner, or smaller portions and eating more vegetable protein. Regarding meat choices, "less but better" may be improved in different ways. One interpretation is that it is favored by extensively produced meat, such as organic and free-range meat, over intensively produced meat. De Boer and

colleagues have analyzed the willingness to adopt a meat free day and the willingness to adopt a plant protein substitute (de Boer 2009). Their data consist of a sample of 1083 consumers in the Netherlands based on a survey among consumers with Internet access. The stratified sample was drawn from a large panel of persons who were willing to participate in web-based research for a small reward. The subject of meat substitution was introduced with a question deliberately substituting something for meat. The first results on the preferred meat portion size reveals that the preferred meat portion size significantly increased with number of meat eating days and BMI category, but decreased with a preference for plant-based proteins, being female, increased age, and higher level of education. Results confirm that a substantial number of consumers do not understand or appreciate the idea that they would have to eat less meat exclusively or primarily for environmental reasons.

## CONCLUSION

Considering advances in the economic and sensory research on preference for novel foods such as GM foods, or the research on food labels, the work done regarding the preference for NPF is tiny. First investigations reveal that the behavior of the consumer whilst choosing legumes is little documented whereas the question is complex from both social and nutritional viewpoints. Results confirm that a substantial number of consumers do not appreciate the idea that they would have to eat less meat, for any reasons (de Boer 2009, Vogel 2010, Pascucci and de-Magistris 2013). The structure of meals is closely connected to meat's status in society, as it was for wine in some countries. Physiological and nutritional considerations interfere with social attitudes. The perception of vegetable proteins as being a protein of the poor considerably limits dietary evolution. It is unimaginable in the European culture to host people without meat for the dinner.

From a nutritional perspective, asking consumers to eat less meat may trigger not only resistance to change but also confusion regarding amounts and sources of proteins. A change at the level of macronutrients is hardly managed by individuals. Humans regulate their protein intake by selecting a low/high-protein food. After a protein deficit, people tend to select, savory high-protein foods (Griffioen-Roose et al. 2012), consciously or unconsciously. This healthy correction mechanism may not work properly if people are changing their diets.

As we see, numerous factors impinge on the preference for plant protein, not only the consumer's budget. Cultural positions and cooking constraints are real barriers to the entry of legumes in the daily meal of the European citizens. A lot is still to be done on the economics of the consumer behavior regarding these promising protein sources. Considering the current lack of information from the economic literature on legume consumption and buyers patterns, we have to focus on the intrinsic (taste, color, easy to make) and extrinsic attributes (effects on the climate change, water pollution) of the legumes. Experimental markets offer appropriate tools for this exercise. The control of the product characteristics permit questions on future marketing trends.

## References (34)

Aiking H. 2011. Future protein supply. Trends in Food Science & Technology 22: 112-120

Aiking H., de Boer J., Vereijken JM. 2006. Sustainable protein production and consumption: Pigs or peas? Environment & policy. 45

Buttriss J. 2013. Food security through the lens of nutrition. Nutritional Bulletin. 38:254–261

Carlsson-Kanyama A., Faist, M. 1999. Energy Use in the Food Sector: A data survey By Environmental Strategies Research Group, Stockholm, 36 p.

Cavaillès E., 2009. La relance des légumineuses dans le cadre d'un plan protéine : quels bénéfices environnementaux ? Collection « Études et document » du Service de l'Économie, de l'Évaluation et de l'Intégration du Développement Durable (SEEIDD) du Commissariat Général au Développement Durable (CGDD), Paris, 44 p.

CBI, 2010. CBI market survey: the rice and pulses market in The EU. CBI market information database, p.54.

de Boer J., Schösler H., Aiking H. 2014. "Meatless days" or "less but better"? Exploring strategies to adapt Western meat consumption to health and sustainability challenges. Appetite. 76: 120–128

de Boer J., Boersema JJ., Aiking H. 2009. Consumers' motivational associations favoring free-range meat or less meat. Ecological Economics. 68: 850–860.

de Boer J., Helms M., Aiking H. 2006. Protein consumption and sustainability. Diet diversity in EU-15. Ecological Economics. 59: 267–274.

Crews TE. and Peoples MB. 2004. Legume versus fertilizer sources of nitrogen: ecological tradeoffs and human needs. Agriculture, Ecosystems and Environment, 102: 279-297

FAO, WFP and IFAD. 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO.

Griffioen-Roose S., Mars M., Siebelink E., Finlayson G., Tomé D., de Graaf, C. 2012. Protein status elicits compensatory changes in food intake and food preferences. The American Journal of Clinical Nutrition. 95: 32–38.

Klemcke S., Glende S., Rohn S. 2013. The revitalisation of native grain legumes - Survey on buying habits and assessment of image of legumes. Ernaehrungs Umschau international. 60(4): 52–58.

Laestadius L.I., Neff R.A., Barry C.L., Frattaroli, S. 2013. Meat consumption and climate change. The role of non-governmental organizations. Climatic Change. 120: 25–38.

Langyintuo AS., Ntoukamb G., MurdockL., Lowenberg-DeBoer J., Miller DJ. 2004. Consumer preferences for cowpea in Cameroon and Ghana. Agricultural Economics. 30: 203–213

Langyintuo AS., Lowenberg-DeBoer J., Fayec M., Lambert D., Ibrod G., Moussad B., Kergnae A., Kushwahaf S., Musaf S., Ntoukam G. 2003. Cowpea supply and demand in West and Central Africa. Field Crops Research. 82: 215–231

Marlow H.J., Hayes W.K., Soret S., Carter R.L., Schwab E.R., Sabaté J. 2009. Diet and the environment: Does what you eat matter? American Journal Clinical Nutrition. 89:1699S–1703

McCluskey, JJ., Grimsrud KM., Ouchi H., Wahl T.I.. 2003. "Consumer Response toGenetically Modified Food Products in Japan," Agricultural and Resource Economics Review. 32(2):222–231

Mihalopoulos, Vassilis; Demoussis, Michael, 2000 Consumption Profiles for Various Food Groups in Greece- Agricultural Economics Review. vol. 1(2), pp. 46-56

Orskov ER. 1990. Energy nutrition in ruminants. New York: Elsevier

PBL (Netherlands Environmental Assessment Agency), 2011. The protein puzzle. The consumption and production of meat, dairy and fish in the European Union. Bilthoven: Planbureau voor de Leefomgeving.

Pascucci S., de-Magistris T. 2013. Information Bias Condemning Radical Food Innovators? The Case of Insect-Based Products in the Netherlands. International Food and Agribusiness Management Review 16, Issue 3, 2013

Rao, Parthasarathy, Birthal P.S., Bhagavatula S. and Bantilan M.C.S. 2010. Chickpea and Pigeonpea Economies in Asia: Facts, Trends and Outlook. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 76 pp. ISBN: 978-92-9066-530-4.

Reynolds CJ., Buckley JD., Weinstein P., Boland P. 2014. Are the Dietary Guidelines for Meat, Fat, Fruit and Vegetable Consumption Appropriate for Environmental Sustainability? A Review of the Literature, Nutrients, 6(6): 2251–2265

Schösler H., de Boer J., Boersema JJ.. 2012. Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution. Appetite. 58: 39–47

Shrapnel B., Baghurst K., 2007. Lack of nutritional equivalence in the 'meats and alternatives' group of the Australian guide to healthy eating. Nutr. Diet. 64:254–260

Smil V. 2002. Worldwide transformation of diets, burdens of meat production and opportunities for novel food proteins. Enzyme and Microbial Technology 30 305–311

Swamy G. 2010. Will Indians stop consuming Pulses? Draft, February 2010.

Reijnders, L. and Soret, S., 2003. Quantification of the environmental impact of different dietary protein choices. *American Journal of Clinical Nutrition (*78) 664–668

Roy P., Nei D., Orikasa T., Xu Q., Okadome H., Nakamura N., Shiina T. 2009. A review of life cycle assessment (LCA) on some food products. Journal of. Food Engineering. 90:1–10.

Van Middleaar C., Cederberg C., Vellinga TV., van der Werf H., de Boer I., 2013 Exploring variability in methods and data sensitivity in carbon footprints of feed ingredients. The International Journal of Life Cycle Assessment. 18(4) 768-782

Vieux F., Darmon N., Touazi D., Soler L.G. 2012. Greenhouse gas emissions of self-selected individual diets in France: Changing the diet structure or consuming less? Ecological Economics. 75:91–101.

Vogel, G. 2010. For more protein, filet of cricket. Science. 327: 811.

Worrell R., Appleby M.C. 2000 Stewardship of natural resources: Definition, ethical and practical aspects. J. Agric. Environ. Ethics. 12:263–277

## Annex 1. Results of the research in databases related to consumer study and Novel Protein Food

**WOS** (from Web of Science Core Collection)**. Results: 7**

You searched for: TI=(LEGUME and CONSUMPTION) OR TI=(PROTEIN and WILLINGNESS TO PAY) OR TI=(VEGETABLE AND PROTEIN) OR TI=(NOVEL PROTEIN FOOD)
Refined by: DOCUMENT TYPES: (ARTICLE OR PROCEEDING PAPER)

No results for:

- TI=(LEGUME and WILLINGNESS TO PAY)
- TI=(PULSE and WILLINGNESS TO PAY)

**SCOPUS. Results: 01**

(TITLE(NOVEL PROTEIN FOOD))

No results for:

- (TITLE(LEGUME) AND TITLE(CONSUMPTION OR WILLINGNESS TO PAY))

**CAB Abstract. Results: 00**

(TITLE(NOVEL PROTEIN FOOD))
(TITLE(LEGUME) AND TITLE(CONSUMPTION OR WILLINGNESS TO PAY))

No results

**Others databases. Results: 09**

(TITLE(NOVEL PROTEIN FOOD))
(TITLE(LEGUME) AND TITLE(CONSUMPTION OR WILLINGNESS TO PAY))

**Econlit: 0 results,**

ScienceDirect: 7 results
Wiley: 1 results
Cairn: 1 result

These 17 references are:

- From 1990 to 2014
- Document types: Journals: 15 + Book and book section: 4

These publications do not correspond to specialized journals or authors, with the exception of a few journals, Appetite, Food Quality and Preference.

There are no scientific and professional communities structured around Legume consumption. One team is distinguished for its work on meat substitute in WU.

## Annex 2. Corpus description

The analysis reveals three groups of references (table 1):

- First, 11 references dealing with Legume Markets and Environmental Impact;
- Second,19 dealing with Novel Protein Food;
- Third, 4 dealing with Method for the Estimation of the Consumer Preference for Legumes.

**Table 1: Topics and Subtopics related to Legume and Pulse consumption**

| **Topic** | **Number** | **Sub-topic** | **Number** |
|---|---|---|---|
| Legume Markets & Environment | 11 | Legume Supply Chain<br><br>Plant Protein Efficiency | 6<br><br>5 |
| Meat Substitutes and Novel Protein Food (other thant Legumes) | 19 | Shifts from Meat to Meat Substitutes<br><br>Novel Food Preferences and Barriers to Entry | 8<br><br>11 |
| Understanding Consumer Attitude Toward Legumes | 4 | Experimental Market of Legume<br><br>Qualitative analysis of Legume Willingness to Buy<br><br>Hedonic Prices on Legume Markets | 0<br><br>3<br><br>1 |
| Total | 34 | | 34 |