

# PLANT MILK REPORT





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# IMPRINT

The Plant Milk Report is a publication of ProVeg e.V.  
Publication Date: October 2019  
ISBN 978-3-948516-00-0

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**Recommended citation form:**

ProVeg e.V. (2019): Plant Milk Report 2019. Berlin

**ProVeg e.V.**

ProVeg is a leading international food awareness organisation working to transform the global food system by replacing animal products with sustainable, humane, just, and healthy alternatives. Our mission is to reduce global animal consumption by 50% by 2040.

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# LIST OF ABBREVIATIONS

CMA	Cow's milk allergy
CMO	Common organisation of the markets in agricultural products
CO <sub>2</sub> eq	CO <sub>2</sub> equivalent
ECJ	European Court of Justice
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCRN	Food Climate Research Network
FDA	Food and Drug Administration
GHG	Greenhouse gas
GMO	Genetically modified organism
HDL	High-density lipoprotein
HKD	Hong Kong Dollar
IFIC	International Food Information Council
LDL	Low-density lipoprotein
NDCI	Nutrient density to climate impact
UK	United Kingdom
UN	United Nations
USA	United States of America
USD	United States Dollar
VAT	Value-added tax
IPCC	Intergovernmental Panel on Climate Change
WHO	World Health Organization



## FOREWORD

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The plant milk market is growing. Recently the *Guardian* referred to plant milk as “white gold” in a report on the unstoppable rise of alternative milks.<sup>1</sup>

I agree fully with this assessment. Plant milk is the top-selling product in the entire plant-based-alternatives market sector, offers numerous health benefits, and has a much smaller ecological footprint than cow’s milk. Nevertheless, in some countries, plant milk production is politically disadvantaged due to unfair tax policies and frameworks for naming these products.

As an international food awareness organisation, ProVeg is working to transform the global food system. Our mission is to reduce global animal consumption by 50% by 2040. And our vision is a world where everyone chooses delicious and healthy food that is good for all people, animals, and the planet. To achieve this goal, ProVeg promotes and supports the development and distribution of attractive, affordable, and available alternatives to animal-based products.

Based on current studies, this detailed report from ProVeg explores the role that plant milks can play in global health and nutrition, from producers through to distributors and consumers. It is time that the world pays attention to the plant-based future of milk.

**Sebastian Joy**  
CEO of ProVeg

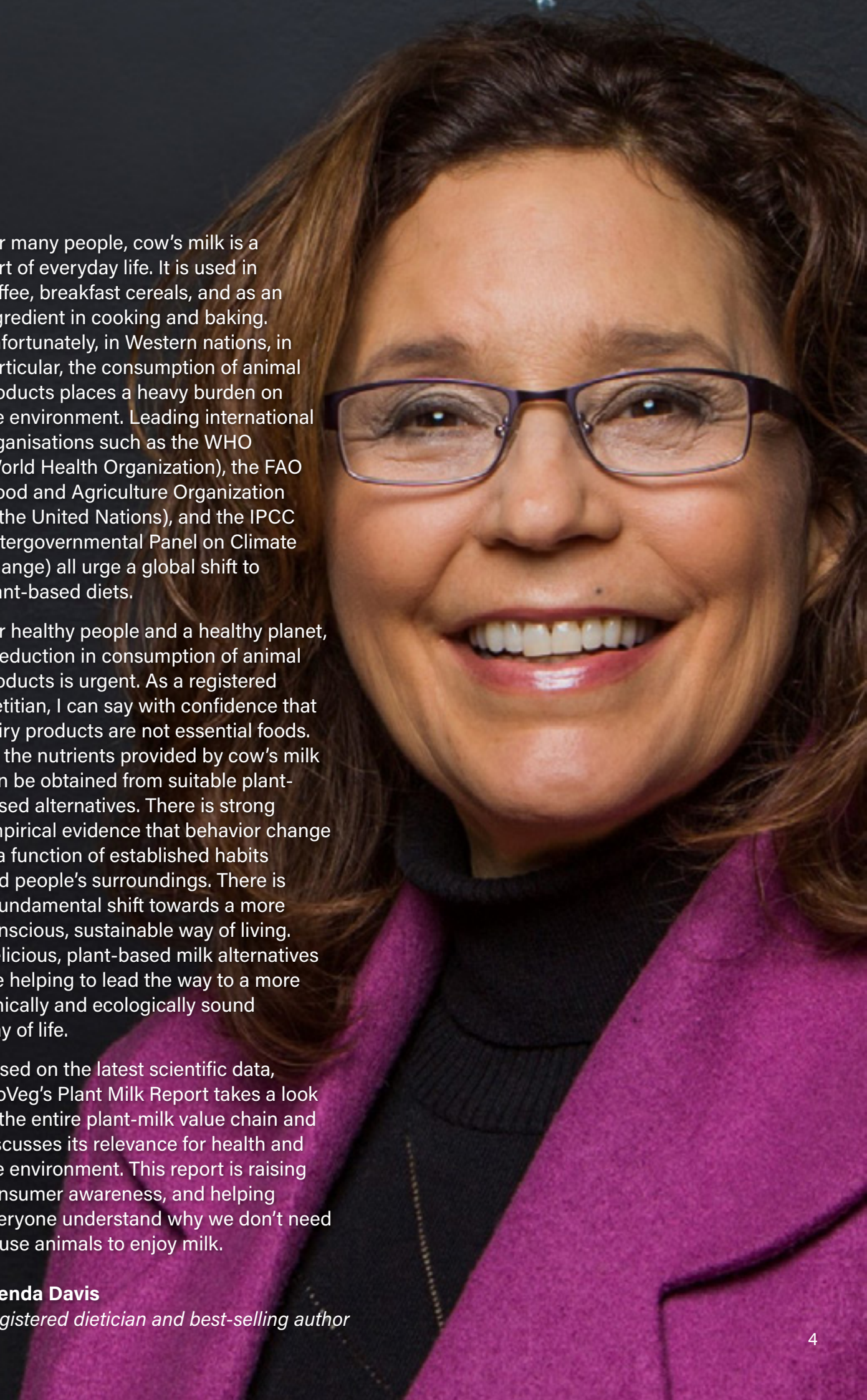


For many people, cow’s milk is a part of everyday life. It is used in coffee, breakfast cereals, and as an ingredient in cooking and baking. Unfortunately, in Western nations, in particular, the consumption of animal products places a heavy burden on the environment. Leading international organisations such as the WHO (World Health Organization), the FAO (Food and Agriculture Organization of the United Nations), and the IPCC (Intergovernmental Panel on Climate Change) all urge a global shift to plant-based diets.

For healthy people and a healthy planet, a reduction in consumption of animal products is urgent. As a registered dietitian, I can say with confidence that dairy products are not essential foods. All the nutrients provided by cow’s milk can be obtained from suitable plant-based alternatives. There is strong empirical evidence that behavior change is a function of established habits and people’s surroundings. There is a fundamental shift towards a more conscious, sustainable way of living. Delicious, plant-based milk alternatives are helping to lead the way to a more ethically and ecologically sound way of life.

Based on the latest scientific data, ProVeg’s Plant Milk Report takes a look at the entire plant-milk value chain and discusses its relevance for health and the environment. This report is raising consumer awareness, and helping everyone understand why we don’t need to use animals to enjoy milk.

**Brenda Davis**  
Registered dietitian and best-selling author







## SUMMARY

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Considering that 75% of the world's adult population is lactose intolerant, it's not surprising that plant milk is the top-selling product in the entire veggie sector. But it's not just about lactose intolerance – people choose plant milks over cow's milk for a variety of reasons, whether it is for their nutritional value, animal welfare, lower environmental impact, to avoid dairy-milk allergens, or simply out of personal preference. One in two American and European consumers uses plant milk, either by itself or in addition to cow's milk, while in the Asia-Pacific and Latin American regions, more than two thirds of all consumers regularly use plant-milk.

In general, more and more consumers are diversifying their diet with plant-based alternatives and consuming fewer animal-based products. There is an urgent need for this since the livestock sector is responsible for about 16% of all anthropogenic greenhouse gas emissions. Indeed, the Food and Agriculture Organization of the United Nations (FAO) has stated that the livestock sector is a significant contributor to climate change. And, in fact, the water footprint of any animal-based product is bigger than the water footprint of plant-based products with an equal nutritional value. Compared with the different varieties of plant milk, cow's milk has the biggest environmental impact in terms of greenhouse gas emissions and land and water use.

Although health, environmental, and animal welfare aspects clearly speak in favour of the use of plant milk, the industry is politically disadvantaged in some countries. Plant milk has been used for decades and, over time, terms such as 'soya milk' have established themselves in everyday language. Nevertheless, in the European Union (EU) it is not permitted to label plant-based milk alternatives with the word 'milk'. In the EU, such beverages are only allowed to be referred to as 'drinks'. In Africa, Asia, Australia,

and America, on the other hand, there are either no special regulations or it has been established as common practice to label plant-based drinks with names such as 'soya milk', 'almond milk', 'rice milk', and so on. The taxation of plant milk in the EU also varies from country to country, although some countries do not distinguish between cow's milk and plant milk. In Germany, for example, plant milk bears a 19% value added tax (VAT) and is classified as a luxury food, while cow's milk carries only a 7% VAT surcharge.

Meanwhile, numerous scientists and startups are working on producing lab-grown versions of the proteins that are found in cow's milk, such as casein and whey, but without the need for animals. Manufacturers argue that the production of cellular milk requires less energy, greenhouse gas emissions, and land usage and is thus more resource-efficient than dairy farming. What sounds like science fiction has already been well established in other areas and represents an interesting field of research for future food. This is also the conclusion of the United Nations Environment Programme.

However, plant milk is not receiving sufficient attention in many national nutrition policies. Since milk has become part of everyday life for many people, the use of plant milk contributes to a healthy, balanced diet and, at the same time, reduces personal food-related environmental impacts without having to completely change one's eating habits. Thus far, 23 countries have integrated plant milk into their national nutrition guidelines as an alternative to cow's milk. However, most countries still need to do so.

This report documents the rise of plant milk in recent years, and explores its potential importance in terms of establishing a healthy and sustainable diet for the planet.



## DEFINITION OF PLANT MILK

Plant milks, also known as plant-based milk alternatives, are generally an extract of legumes, cereals, nuts, and/or seeds, diluted in water. They are very similar to animal milk in terms of texture, appearance, and use. Depending on the raw materials and fortification, they differ in their nutritional composition and taste, but none of them contain any lactose or cholesterol.

The popularity of plant milks has skyrocketed over the past decade. But such drinks have been consumed for centuries in various cultures. In Spain, for example, tigernut milk, also known as *horchata de chufa*, is a popular national drink. In Korea, people drink *sikhye*, a traditional beverage made from cooked rice, malt extract, and sugar. *Bushera* is a traditional Ugandan beverage made from fermented sorghum or millet grains and water.<sup>2</sup> And, in China, soya milk has a long history, with its use first recorded about 2,000 years ago.<sup>3</sup>

## VARIETIES OF PLANT MILK AND THE MANUFACTURING PROCESS

There is a huge variety of milk alternatives, derived from a wide range of plant sources. Theoretically, any type of legume, grain, nut, or seed can be made into a milky drink.

In general, plant milk can be classified into five categories:

- Legume-based milks (made from soya, lupins, peanuts, etc.)
- Cereal-based milks (made from oats, rice, spelt, corn, etc.)
- Pseudo-cereal-based milks (made from quinoa, amaranth, teff, etc.)
- Nut-based milks (made from almonds, hazelnuts, coconut, macadamia nuts, pistachios, etc.)\*
- Seed-based milks (made from hemp seeds, flax seeds, sesame seeds, sunflower seeds, etc.)

Traditionally, the raw materials for the production of plant milk are soaked in water and then milled or ground, after which a sieve is used to remove larger plant particles. There are other variations, but the established industrial process is quite similar: the raw materials are soaked in water and then ground, after which the solid matter is separated from the milk by filtration. Alternatively, depending on the base materials, they can also be ground in their dry form and then blended with water.<sup>2</sup> And, with some variations, there is no filtration process.

Depending on the product and manufacturer, additional ingredients such as oil, sugar, flavourings, and stabilisers are added. This is followed – similarly to cow's milk – by homogenisation and heat treatment. The homogenisation of milk is a mechanical treatment in which the fat globules are crushed under high pressure and dispersed uniformly through the rest of the milk, resulting in a smoother drink. To increase shelf life and emulsion stability of plant milk, different heat treatments such as pasteurisation (less than 100 °C) or ultra-high temperature treatment (135-150 °C) are used.<sup>3</sup> Depending on the length of time and temperature, vitamin losses may occur during these steps in the process, while proteins and secondary plant substances are not affected.<sup>2</sup> Furthermore, some manufacturers fortify their plant milk with calcium, vitamin B<sub>12</sub>, omega-3 fatty acids, and/or other added nutrients.

\*Not all foods listed here are technically nuts. Nevertheless, they are classified in the nut-milk category by the general public, companies, and in many publications. We have therefore decided to do the same.

## THE PLANT MILK MANUFACTURING PROCESS





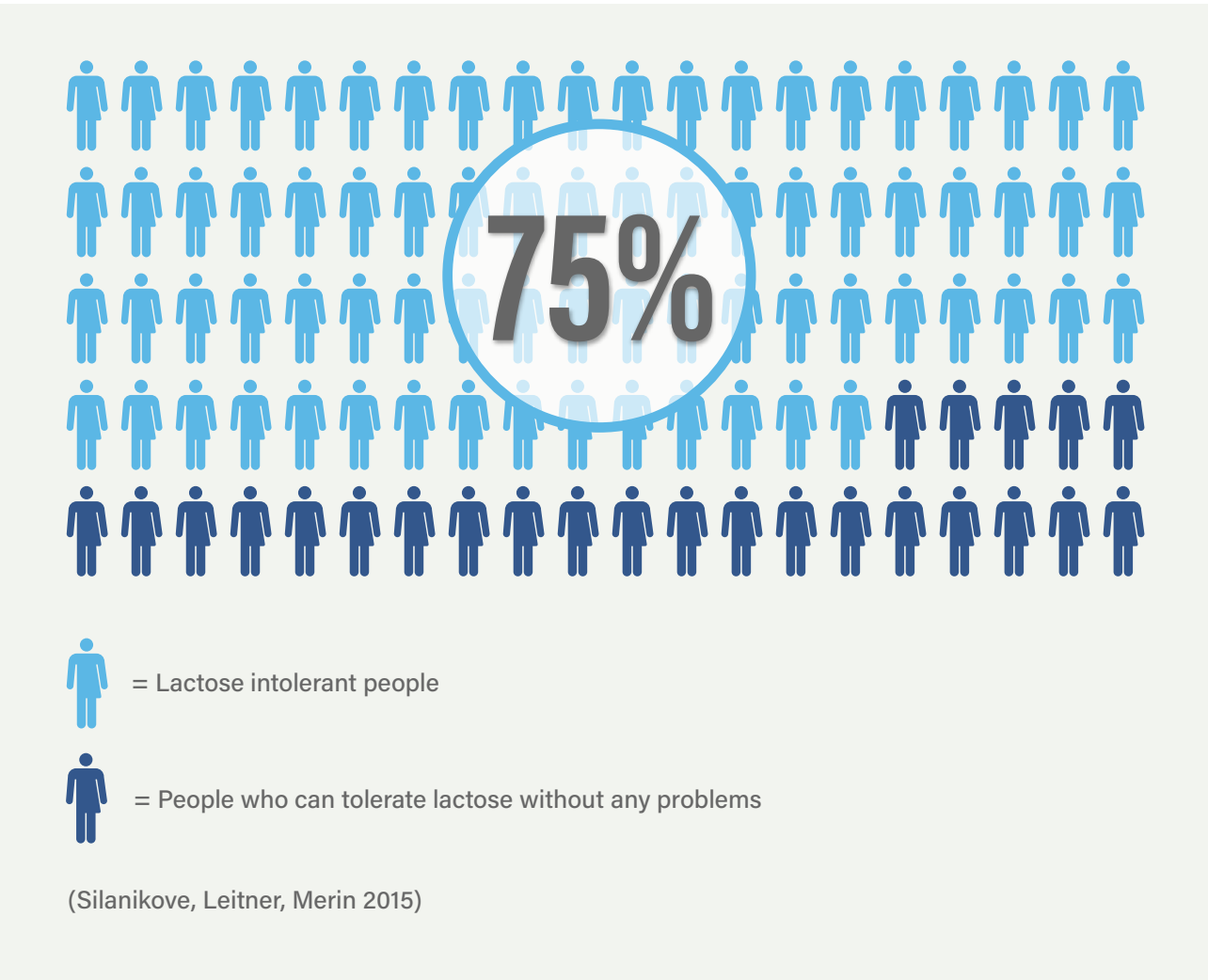
# NUTRITIONAL VALUES AND HEALTH FACTS

Each of the different varieties of plant milk has a unique nutritional profile as there is a wide variance in the content of proteins, carbohydrates, and fats, as well as vitamins, minerals, and dietary fibre.

From a health perspective, there are various reasons why people prefer plant milk over cow's milk. Most humans, like other mammals, gradually lose the intestinal enzyme lactase after infancy and, with it, the ability to digest lactose, which is the main form of sugar in milk. As much as 75% of the world's adult human population is intolerant to ingested dietary lactose.<sup>4</sup> Another reason is cow's milk allergy (CMA). At 1-3%, CMA is the most common form of food allergy in infants and children, and is the result of an immunological reaction to certain proteins in cow's milk, particularly  $\beta$ -lactoglobulin and casein, which can cause immediate hypersensitivity reactions.<sup>5, 6, 7</sup> Chemical contaminants in milk and dairy products, such as antibiotics, hormones, and pesticides, also play a role in consumer choices. Dairy cows are given antibiotics to control mastitis, parasites, and other diseases, as well as to increase milk production. These drugs are given to animals in various ways, including injections and feed, and can lead to milk and dairy products being contaminated with residues.<sup>8</sup>



# NUMBER OF LACTOSE INTOLERANT PEOPLE IN WORLD ADULT POPULATION



Beyond the health concerns associated with cow's milk, plant milk can enrich one's diet and add variety. Many people in industrialised countries have an unbalanced diet and consume more animal-based products than recommended by national and international health and nutrition organisations. The use of plant milk for drinking, cooking, and baking can help to counteract this.



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## SOYA MILK

Soya milk, still the most popular plant milk, belongs to the legume-based category. It is the only milk alternative that naturally contains the same amount of protein as cow's milk, with about 3 g per 100 ml. Due to the fact that many manufacturers fortify soya milk with calcium and other vitamins, such as B<sub>12</sub>, B<sub>2</sub>, D, and A, nutrition experts state that it can be used as a nutritionally adequate alternative to cow's milk.<sup>2, 9</sup> This is confirmed by the US Department of Health and Human Services and the National Health and Medical Research Council in Australia.<sup>10, 11</sup> In addition, soya milk has similar characteristics to cow's milk when used as a replacement in cooking, baking, and whipping milk for coffee.

**”** *Soy beverages fortified with calcium, vitamin A, and vitamin D, are included as part of the dairy group because they are similar to milk based on nutrient composition and in their use in meals.*

**US Department of Health and Human Services, 2015<sup>10</sup>**

Soya milk also contains ingredients such as isoflavones, which make it particularly beneficial as a part of one's diet. Several studies have shown that the consumption of soya foods can help reduce the risk of heart disease as well as some forms of cancer and osteoporosis.<sup>12</sup>

Soya also has a healthy fatty acid composition. It contains low levels of saturated fatty acids and high amounts of unsaturated fatty acids. If the animal-based protein sources that are rich in saturated fatty acids and which are consumed frequently in western diets, were replaced with soya foods, this could lead to a positive change in the fatty acid content of the general population, potential lowering LDL (low-density lipoprotein) cholesterol levels and reducing the risk of coronary heart disease.<sup>13</sup>

Because of these health benefits, soya milk is also used as a functional ingredient in the production of processed foods such as egg-free mayonnaise.<sup>3</sup> Due to its increasing popularity, soya milk is now also available in variants such as vanilla, chocolate, and banana flavour, as well as a barista version, which is particularly good for making frothed milk. However, as these flavoured versions usually have high amounts of added sugar, they should be consumed in moderation.

The only disadvantage of consuming soya milk is the prevalence of soya allergies, which makes it unsuitable for people allergic to soya proteins.<sup>3</sup> Other claims about the harmful effects of soya consumption on health are often one-sided and not representative, and are frequently engineered to cause controversy.

For example, soya supposedly has a feminising effect on the human body due to the presence of isoflavones, whose structure resembles that of the human hormone estrogen. This alleged effect stems from two published case studies discussing the effects of soya foods in two individual men who, in the context of an unbalanced diet, had above-average isoflavone consumption (360 mg/day isoflavones) and an increase in estrogen levels.<sup>14, 15</sup> These results are far from being representative. In contrast, there have been numerous clinical studies in which men consumed up to 150 mg/day of isoflavones, with no effect on estrogen levels.<sup>16</sup> Additionally, the results of the widely recognised Adventist Health Study (with a sample of over 12,000 men) led to the conclusion that regular soya milk consumption can reduce the risk of prostate cancer.<sup>17</sup>

Thus, the evidence suggests that soya foods can be safely consumed by all individuals except those with an allergy to soya protein, which is relatively rare compared to the number of individuals allergic or intolerant to other commonly consumed foods such as cow's milk.<sup>13</sup> Moreover, soya offers the aforementioned health benefits.



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## ALMOND MILK

Almond milk has become an increasingly popular dairy alternative in recent years but it isn't as new as you might think. In the Middle Ages, almonds were already being used in Europe to produce milk substitutes, as they could be stored for longer and remain nutrient rich.<sup>18</sup> Almonds contain high amounts of fibre, calcium, magnesium, riboflavin, and unsaturated fatty acids, and frequently appear in nutritional recommendations and guidelines.<sup>19, 20</sup> Vitamin E (Alpha-Tocopherol), in particular, has been found in remarkable amounts in almonds, and has been shown to play a central role in protecting against oxidative stress.<sup>21</sup>

Although almonds contain high amounts of protein (around 20%), the disadvantage of industrially manufactured almond milk is that the protein content is filtered out together with the pulp, which leaves only around 0.5% protein. And because almond milk is so strongly diluted with water, it is relatively low in calories but also much lower in nutrients, compared to unprocessed almonds.<sup>9, 19</sup>

Research indicates that almond milk can be a particularly good solution for children suffering from allergies or intolerances to animal milk.<sup>22, 23</sup> For example, a study of 52 infants with either cow's milk allergies or intolerances or both, showed that almond-milk-based infant formula is tolerated better than the commonly used formula based on hydrolysed cow's milk protein or soya, while growth rates were the same for all control groups.<sup>23</sup> Furthermore, the Academy of Nutrition and Dietetics recommends enriched almond milk as a good alternative for children who cannot or do not want to drink cow's milk. As products vary from manufacturer to manufacturer, consumers should compare on-pack nutrition information, with particular attention paid to calcium, protein, and vitamin D.<sup>24</sup>





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## OAT MILK

Oat milk, which belongs to the group of cereal-based milks, is another popular alternative to dairy milk. With their high content of dietary fibre, phytochemicals, and antioxidants, oats are a particularly healthy food. Studies show that regular consumption of oats can have a positive effect on gastrointestinal problems as well as being anticarcinogenic. Furthermore, several publications have attested to the cholesterol-lowering properties of oats.<sup>25</sup>

The rising popularity of oats, along with an increased public awareness of its health benefits, has led to renewed interest from the food industry, which is increasingly using oats as an ingredient in various products, including breads, breakfast cereals, and, of course, oat milk.<sup>25</sup> Oat milk contains more sugar than other plant milks (about 4%) and therefore tastes slightly sweet. However, sugar is a natural component of oats, so oat milk usually contains no added or processed sugar. Its protein and fat content, on the other hand, is rather low. (see table 'Nutrition profiles for different types of milk')

Several studies have evaluated oat milk's impact on health. One such study, a randomised, double-blind control trial, analysed how the consumption of oat milk affected the cholesterol levels in men with hypercholesterolemia, a disease characterized by a very high level of cholesterol in the blood. The 66 participating men were randomly assigned to two groups, which consumed either 0.75 litres/day of oat milk or 0.75 litres/day of a control drink (rice milk) for five weeks. After a five-week break, the two groups switched their beverage schedules. The results show that, compared to the control drink, the intake of oat milk led to a significantly lower total cholesterol level in serum and LDL cholesterol.<sup>26</sup> Another study showed that replacing low-fat cow's milk with oat milk can lower plasma cholesterol and LDL levels in healthy people after four weeks of consumption.<sup>27</sup>



Picture by Homelesscuisine, Shutterstock

## COCONUT MILK

Coconut milk is an important element of Asian cuisine. But there is a difference between canned coconut milk and coconut milk in a carton. While canned coconut milk has a high fat content and is used for curries, stews, and other dishes, coconut milk in a carton, also referred to as a coconut beverage or drink, is more diluted with water and sometimes also enriched with vitamins. This type of coconut milk is used as a milk substitute in coffee, milkshakes, and cereals. Because it is less concentrated than the canned version, coconut milk beverage not only contains less fat and fewer calories, but also has a relatively low protein content.

Various studies have evaluated coconut milk and the impact of its consumption on health. It is said to boost the immune system and have an anti-carcinogenic and anti-bacterial effect.<sup>3</sup> The consumption of coconut milk has been shown to increase HDL (high-density lipoprotein) levels, which helps to reduce harmful LDL levels, which, in turn, lowers the risk of coronary heart disease. It is thought that this is due to the lauric acid contained in coconut fat.<sup>28, 29</sup> On the other hand, there are also publications that point out that coconut oil increases LDL levels. However, according to current knowledge, coconut milk can be a healthy addition to one's diet, but it should not be the only milk alternative used due to its saturated fatty acids. In general, one should consume less of these than unsaturated fatty acids. A balanced and varied selection of food is generally the healthiest choice.





Picture by Evan Lorne, Shutterstock

## RICE MILK

From a nutritional point of view, rice milk, which is a cereal-based milk, offers no advantages over other plant milks, save for the fact that it is the most hypoallergenic milk available and therefore particularly suitable for people with allergies and intolerances. Rice milk is comparatively high in carbohydrates but low in fat, protein, and other nutrients if not enriched or fortified. During processing, the carbohydrates are split into sugars, which gives rice milk its typical sweet taste without adding any sugar.<sup>30</sup>

Rice milk may be the best alternative for allergy sufferers, but when it comes to child nutrition, the arsenic content of rice must also be taken into account. Arsenic is a metalloid that is toxic to humans and a natural component of the environment. It occurs in soil, water, air, and thus also in food. Compared to other cereal crops, rice tends to take up more arsenic – in both its organic and inorganic form – from the environment. However, rice and rice milk can still be part of a healthy balanced diet. There are maximum legal limits on the amount of inorganic arsenic allowed in rice and rice products, with even stricter limits applied to foods intended for young children. For example, the United Kingdom Food Standards Agency examined 60 samples of rice drinks for arsenic levels and found low levels of concentrations in all samples. As such, the agency advises against feeding infants and small children rice milk but, for all other consumers, consuming rice milk is safe.<sup>31</sup>



Picture by Julia Metkalova, Shutterstock

## OTHER PLANT MILKS

Other plant milk, such as lupin, cashew, quinoa, flax, hemp, walnut, hazelnut, etc, are commercially available in some countries but scientific literature on these milks is sparse. Based on the manufacturer's specifications, only milk made from sweet lupins contains more calories than cow's milk, with 78 kcal/100 ml (compared to 67 kcal/100 ml <sup>32</sup>), whereas the majority of the alternative products have less calories than cow's milk, with cashew, coconut, and almond milk having the lowest. Additionally, the content of fat in cow's milk<sup>32</sup> is quite high in comparison to the majority of plant milks. Usually, only milks that are made from walnuts and lupins have a higher fat content. However, it is not only the fat content that is important, but also the composition of fatty acids. While cow's, lupin, and coconut milk contain more saturated fatty acids, most plant milks are rich in unsaturated fatty acids, which are preferable. Walnut milk, in particular, contains high amounts of mono- and polyunsaturated fatty acids and, like hemp, pea, and flax milk, it is a good source of omega-3 fatty acids. The amount of carbohydrates differs depending on the core ingredient (as well as any additional components). In general, beverages made from cereals and pseudocereals, such as oat, spelt, rice, buckwheat, and millet, naturally contain sugar and therefore have more carbohydrates than, for example, nut, hemp, or soya milk. In order to improve taste, manufacturers add sugar or sweeteners to some of these products, thus increasing the sugar and carbohydrate content. Unsweetened hemp, cashew, and other nut milks contain little to no sugar.

Studies generally conclude that soya milk is the most adequate substitute for cow's milk in terms of protein content, but, according to manufacturers, pea milk, which has a protein content of 3.33 g/100ml (see table), can also serve as a good source of protein. In contrast, beverages made from spelt or hemp are low in protein.

Healthwise, all plant-based milks correlate with their main ingredients in terms of nutritional value. However, most of the nutrients present in the plant mass are found in only very low concentrations in their milk form due to their being diluted with water.

Concerning mineral and vitamin contents, there are substantial differences between the different brands. Most producers fortify their products in order to sell them as an appropriate alternative to cow's milk. The mineral that is most often added is calcium, in the form of tricalcium phosphate or the algae *Lithothamnium calcareum*. Cow's milk contains about 125 mg of calcium per 100 ml and so most manufacturers of plant milk enrich their products with roughly the same amount (usually 120 mg/100 ml). Other substances that are present in cow's milk and are therefore often added to plant milk in similar amounts include vitamins A, B<sub>2</sub>, B<sub>12</sub>, D, and E.



# NUTRITION PROFILES

## FOR DIFFERENT TYPES OF MILK (per 100 ml of product)


	Cow's milk	Soya milk	Almond milk	Rice milk	Oat milk
Energy [kJ/kcal]	280.3/67	177/42	100/24	209/50	193/46
Fat [g]	3.75	1.9	1.1	1.04	1.5
of which saturated fat [g]	1.25	0.3	< 0.1	0	0.2
of which monounsaturated fat [g]	ns	0.4	ns	0.62	ns
of which polyunsaturated fat [g]	ns	1.2	ns	0.21	ns
Cholesterol [g]	15	0	0	0	0
Carbohydrates [g]	4.58	2.7	2.9	9.58	6.7
of which sugar [g]	4.58	2.5	2.8	4.17	4.1
Fibre [g]	0	0.6	ns	0	0.8
Protein [g]	3.33	3.3	0.5	0.42	1
Sodium [mg]	50	32	52	42	40
Calcium [mg]	125	120	120	100	120
Vitamin A [µg]	37.5	ns	ns	33.3	ns
Vitamin B <sub>2</sub> (Riboflavin) [mg]	0.18	0.21	ns	ns	0.21
Vitamin B <sub>12</sub> [µg]	ns	0.38	0.38	0.26	0.38
Vitamin D [µg]	ns	0.75	0.75	0.52	1.5

(1) Nutritional values according to manufacturer's information or USDA Branded Food Products Database. The following brands were used: Alpro Soya Original, Blue Diamond Original Almond Breeze, Rice Dream Original Rice Drink, Oatly Oat Drink, Koko Dairy Free Original + Calcium, Good Hemp Creamy Seed Milk, Silk Unsweetened Cashewmilk, Ripple Original Nutritious Pea Milk, Good Karma Original Flax Milk, Elmhurst Milked Walnuts, and Made with Luve Lupinen Drink Natur

(2) If only percentages were mentioned, we used the reference intake for food labels FIC ANNEX XIII

(3) ns = not specified

Coconut milk	Hemp milk	Cashew milk	Yellow Pea milk	Flax milk	Walnut milk	Lupine milk
106/27	108/26	43.6/10.42	174.3/41.67	87.15/20.83	226.6/54.17	327/78
2.0	2.7	0.83	1.87	1.04	4.58	4.2
1.9	0.3	0	0.21	0	0.42	3.8
0.1	0.3	0.42	1.25	0	2.5	ns
0	2.1	0	0.42	0.62	1.67	ns
0	0	0	0	0	0	0
1.9	0.1	0.42	2.5	2.92	2.08	7.3
1.6	0	0	2.5	2.92	1.67	2.1
0.1	0	0	0	0	0	0.1
0.2	0	< 1	3.33	0	1.25	2.3
40	ns	66.67	54.17	43.75	41.67	20
120	ns	150	150	100	10	ns
ns	ns	33.3	33.3	33.3	ns	ns
ns	ns	ns	ns	ns	ns	ns
0.38	ns	ns	ns	0.26	ns	ns
0.75	ns	0.52	0.62	0.52	0	ns

 Please note that, as with cow's milk, all the plant milks presented here are unsuitable as milk substitutes for infants. Milk meals in the first year of life should always consist of breast milk or special infant formula. However, plant-based infant formula is also suitable for the healthy development of children.<sup>33</sup>



# ENVIRONMENTAL COMPARISON TO COW'S MILK



Picture by Kraipet Sritong, Shutterstock

Sustainability has become a central issue in the food sector – not only because of the United Nations (UN) Sustainable Development Goals, but also because more and more consumers want to eat more sustainably and are asking critical questions about the production of the food.

The Food and Agriculture Organization of the United Nations (FAO) has stated that the livestock sector is a significant contributor to climate change. The sector is responsible for about 16% of all anthropogenic greenhouse gas (GHG) emissions, with cattle producing 62 percent of livestock sector emissions, and beef and dairy cattle generating roughly equal amounts of greenhouse gases.<sup>34, 35</sup> Worldwide, the top 20 meat and dairy corporations combined produce more greenhouse gas emissions than the whole of Germany, which has the highest greenhouse gas emissions of all EU countries due to its climate-damaging brown coal industry.<sup>36, 37</sup>

But animal agriculture is not only a huge source of emissions – it also destroys Earth's natural defence systems. Large areas of

forests, grasslands, and wetlands are cleared in order to create grazing land or grow feed crops. However, these forests and other wildlands act as important carbon sinks by absorbing CO<sub>2</sub> from the atmosphere, thus counteracting global warming.<sup>38, 39</sup> The protection of these areas is more urgent than ever and only feasible if the demand for animal-based products is reduced.

Since animal-based products need significantly more land area than plant-based foods, a reduction in the consumption of animal-based food could not only save forests but also feed a greater number of people. A study by Cassidy et al. calculated that if the production of animal-based foods (grain-fed) was reduced by 50%, an additional 2 billion people could be fed on the existing agricultural land.<sup>40</sup> Another study, conducted by Erb et al., had similar results and showed that a purely plant-based diet could theoretically feed the increased global population projected to live on Earth by the year 2050 – without any need for additional deforestation to expand the agricultural area.<sup>41</sup>

Another important aspect is water use. Water is a scarce resource and there are still 785 million people who lack access to a basic drinking-water service.<sup>42</sup> The amount of water we drink or use for cooking, laundry, or personal hygiene is only a small contributor in terms of our overall consumption. Instead, the food that we eat determines how much water we require: the agricultural sector uses 70% of the freshwater available worldwide,<sup>43</sup> while the production of animal-based products accounts for almost one third of that water. In fact, the water footprint of any animal-based product is bigger than the water footprint of plant-based products with an equal nutritional value.<sup>44</sup>

“Livestock production accounts for 70 percent of all agricultural land and 30 percent of the land surface of the planet. The livestock sector is one of the top three contributors to the most serious environmental problems, including water-quality degradation, at every scale from local to global.

**Food and Agriculture Organization of the United Nations, 2017<sup>45</sup>**

Livestock farming is worsening the situation, not only because it uses a lot of water, but also because it is a driving factor in the pollution of freshwater resources. Waste from the livestock sector, including manure and veterinary medicines such as antibiotics, vaccines, and growth promoters (hormones), makes its way into ecosystems and drinking-water sources, while zoonotic water-based pathogens are also becoming an increasing threat to public health. As such, the FAO identifies the livestock sector as “one of the top three contributors to the most serious environmental problems, including water-quality degradation, at every scale from local to global.”<sup>45</sup>

A very effective way to reduce these food-related environmental problems is to reduce the production and consumption of animal products, particularly meat and milk. This is also confirmed by a large food production analysis, which evaluated data from 38,700 companies and 1,600 processing, packaging, and retail companies in 119 countries. While, on the producer side, the transition from conventional farming to organic farming or conservation agriculture would have positive effects, the authors of the study see consumers as the key driver of change. “Today, and probably into the future, dietary change can deliver environmental benefits on a scale not achievable by producers,” note Poore and Nemecek in the food production analysis they undertook.<sup>46</sup> They came to the conclusion that the transition to a more plant-based diet could reduce land use by up to 76% and reduce greenhouse gas emissions from the food sector by up to 50%. If consumers halve the consumption of any animal product and replace it with plant equivalents, 10.4 billion tonnes of CO<sub>2</sub> equivalent (CO<sub>2</sub>eq) could be saved annually.<sup>46</sup>

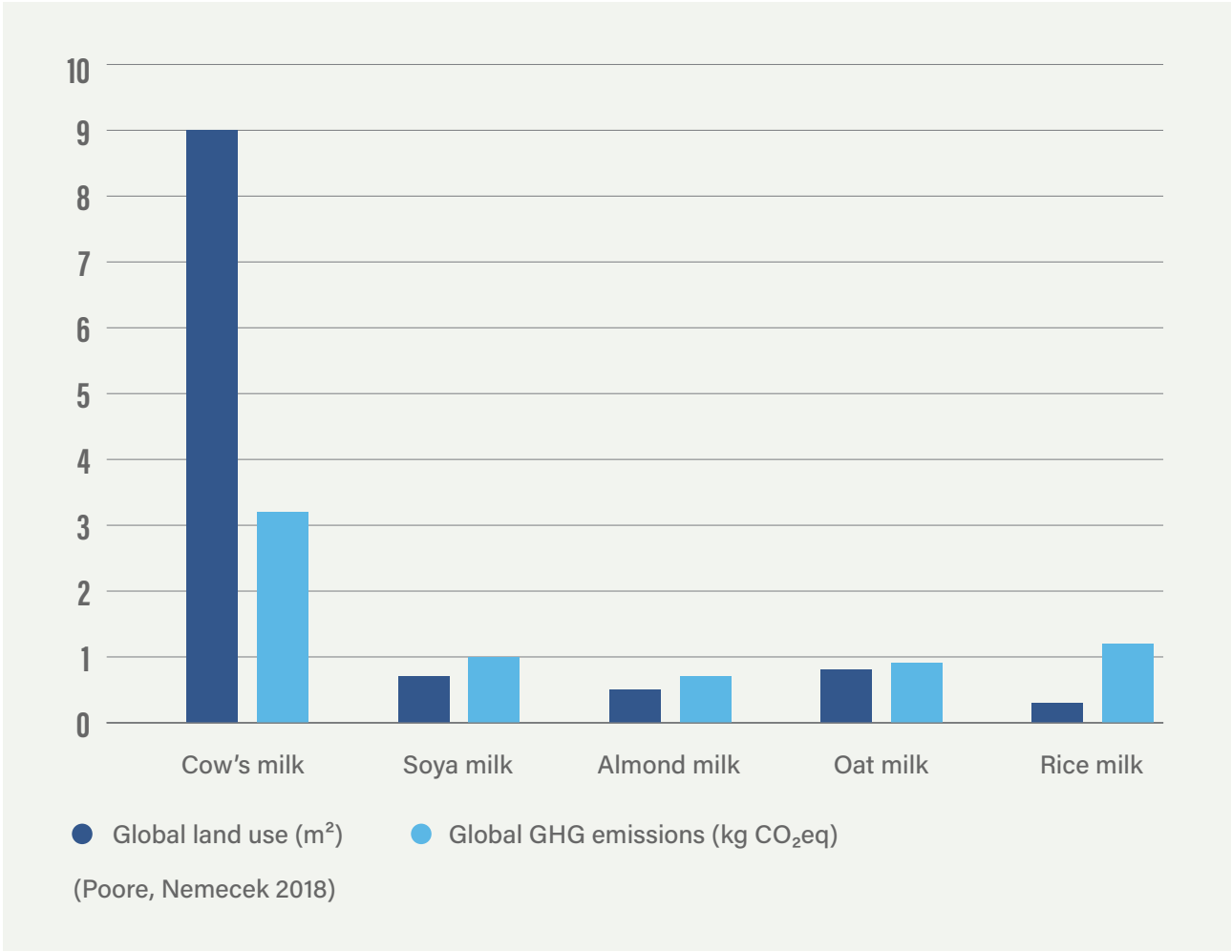
This brings us to the question of just how environmentally friendly plant milk is. Based on their analysis, Poore and Nemecek made an additional calculation, comparing the environmental impact of different milks. They ranked cow's milk and four different types of plant milk in terms of greenhouse gas emissions and land and water use. It turns out that cow's milk has the biggest environmental impact in all areas and requires nine square metres of land and 628 litres of water for each litre produced. In addition, cow's milk results in emissions of 3.2 kg CO<sub>2</sub>eq per litre.



Picture by Jed Packer, Shutterstock



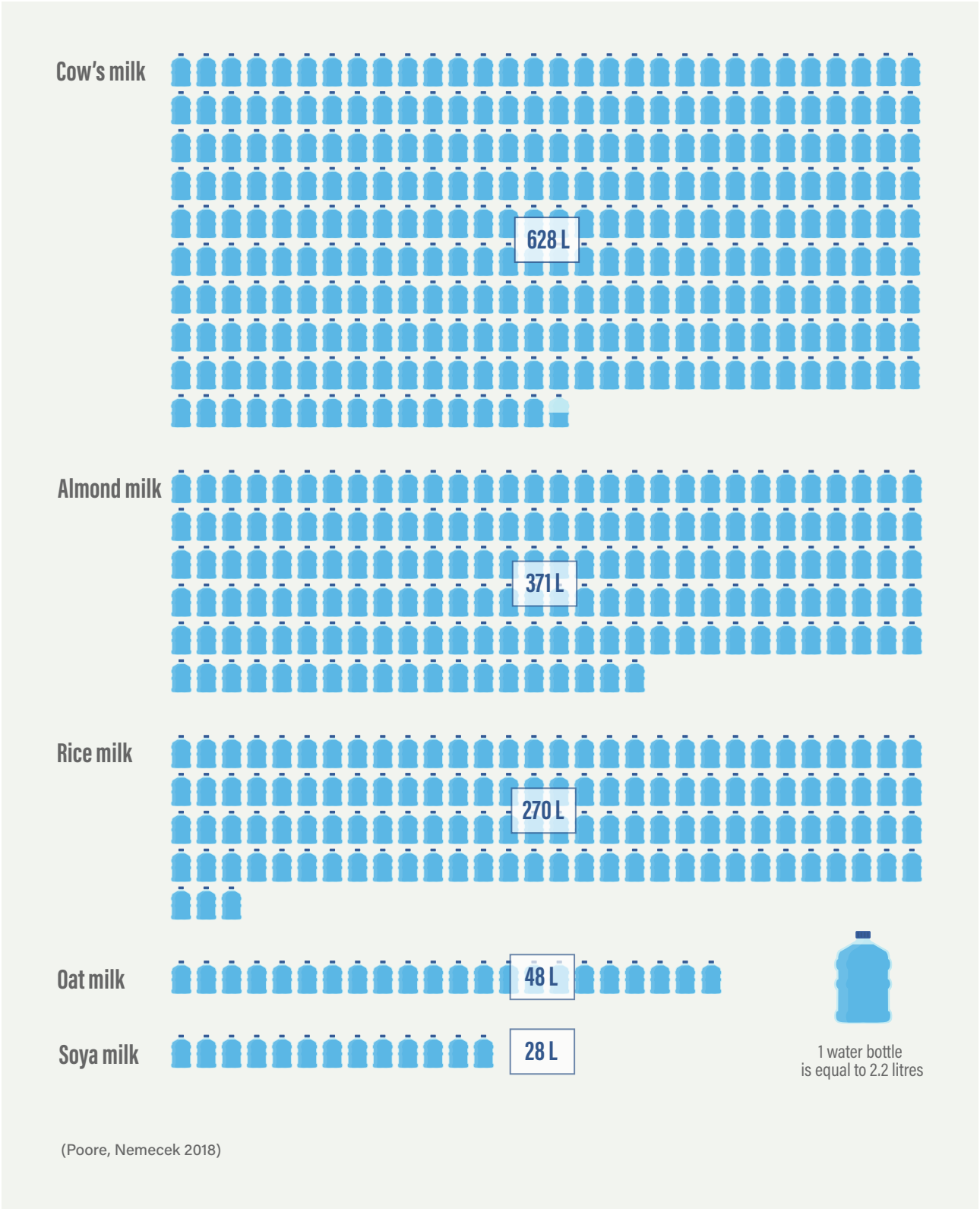
# GLOBAL ENVIRONMENTAL IMPACT OF DIFFERENT TYPES OF MILK PER LITRE



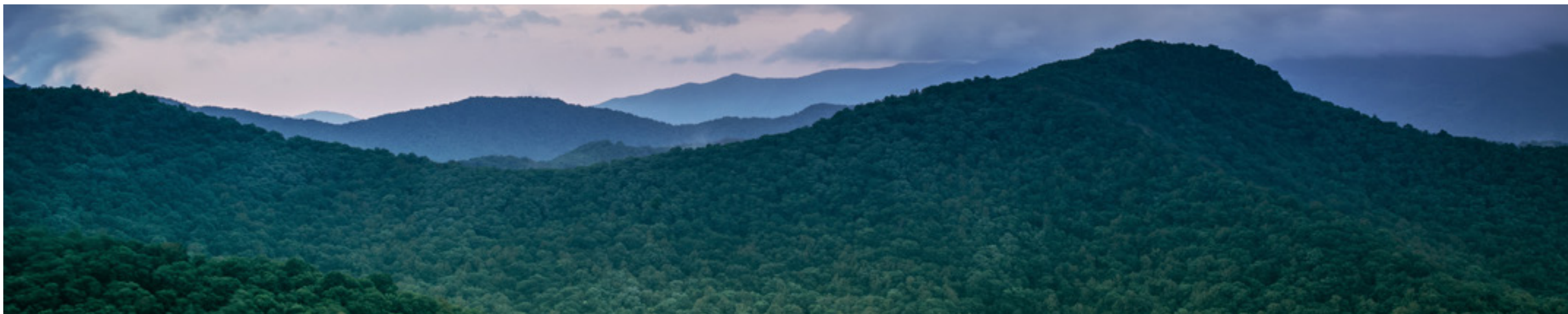
However, although all plant milks are more environmentally friendly than cow's milk, they differ substantially in terms of their greenhouse gas emissions and land and water impact. While all plant milk varieties have a similarly low land usage, almond milk, with 0.7 kg CO<sub>2</sub>eq per litre, has the lowest greenhouse gas emissions, followed by oat milk, with 0.9 kg CO<sub>2</sub>eq, and soya milk, with 1 kg CO<sub>2</sub>eq.

On the other hand, in terms of water use, almond milk has the highest impact, with 371 litres of water used for each litre of product. In contrast, soya and oat milk require the least amount of water at 28 and 48 litres of water per litre of product, respectively.<sup>46, 47</sup>

# THE FOLLOWING AMOUNT OF WATER IS REQUIRED TO PRODUCE A SINGLE LITRE OF MILK







Picture by Jorge Illich-Gejo, Unsplash

A report by the Swedish University of Agricultural Sciences and the Food Climate Research Network confirmed that cow's milk has a higher impact (in terms of water use, ecotoxicity, nitrogen footprint, eutrophication, acidification potential, and negative biodiversity impacts) than most plant milks.<sup>48</sup>

There are currently four different approaches to assessing the environmental impact of food products:

1. By mass [kg of product]
2. By nutrient density [e.g. protein per kg of product]
3. In a dietary context
4. From a production-system perspective<sup>48</sup>

The assessment by product mass is the most commonly used approach (approach 1). It calculates how much land and water is needed to produce a single litre of cow's milk or plant milk and how much CO<sub>2</sub> is emitted. This leads, for example, to the conclusion that one litre of cow's milk emits two to three times as much greenhouse gases [CO<sub>2</sub>eq] as plant-milk alternatives.<sup>48</sup>

Another approach that is used far less often is comparing them on a nutritional basis (approach 2).

For example, one nutrient that can be considered is protein. Since cow's milk in general has a higher protein content than plant milk, the environmental impact of milk seems lower on a protein basis, as more plant milk may be needed to get the same amount of protein. However, there are several reasons to question whether this approach really makes sense. In high-income countries, for example, cow's milk, which is high in calories and saturated fatty acids, is not necessary to supply basic needs. Instead, all national dietary guidelines in developed countries indicate that people should consume fewer calories, fewer animal proteins, and fewer saturated fatty acids. Cow's milk is consumed for pleasure, which makes the comparison by mass more accurate, since the highest cow's milk consumption is also found in high-income countries.<sup>48</sup>

In order to take the various different nutrients into account, Smedman et al. (2010) created a Nutrient Density to Climate Impact (NDCI) score, calculating the amount of each nutrient in the drinks they compared. They considered all nutrients included in the Nordic Nutrition Recommendations (NNR) and the food database of the Swedish National Food Administration\*. For the NDCI score, the nutrient density of a product is divided by the climate impact (g CO<sub>2</sub>eq per 100 g of product). The nutrient density itself is calculated by multiplying the percentage of the NNR recommendation of each

nutrient present in the product by the percentage of nutrients reaching more than five percent of this recommendation and summarising the values. They found that – on the basis of their NDCI score – cow's milk is more climate friendly than unfortified oat and soya milk.<sup>48, 49</sup>

This study was criticised by Scarborough and Rayner (2010), who were concerned that the NDCI index was flawed because it uses an arbitrary choice of threshold (more than 5% of the value given in the Nordic Nutrition Recommendations) and that a different threshold could favour soya drinks or even orange juice.<sup>50</sup> In their article, Smedman et al. do not explain their choice of threshold. Another reason to take a critical look at this study is that three of the five scientists were employed by the Swedish Dairy Association when they did the study.<sup>49</sup>

These examples show that the calculation of climate impact in a nutritional context is complex and that various questions need to be considered. Should all nutrients be regarded equally? Are they of concern in a specific dietary context? Are the nutrients delivered above recommended levels? How are they aggregated? The chosen methodology can strongly affect the results, and studies using a particular approach should endeavour to clarify how their methodological decisions might affect the results.<sup>48</sup>

It is the total impact of all the food a person consumes that determines the final outcomes. As such, the dietary context approach (approach 3) analyses the effects that an overall dietary change – instead of individual products – has on health and the environment. In general, results show that vegan diets have a considerably lower impact on climate and land impact.<sup>51</sup> Only one study found no great reduction in GHG emissions and land use when replacing dairy products.<sup>48</sup>

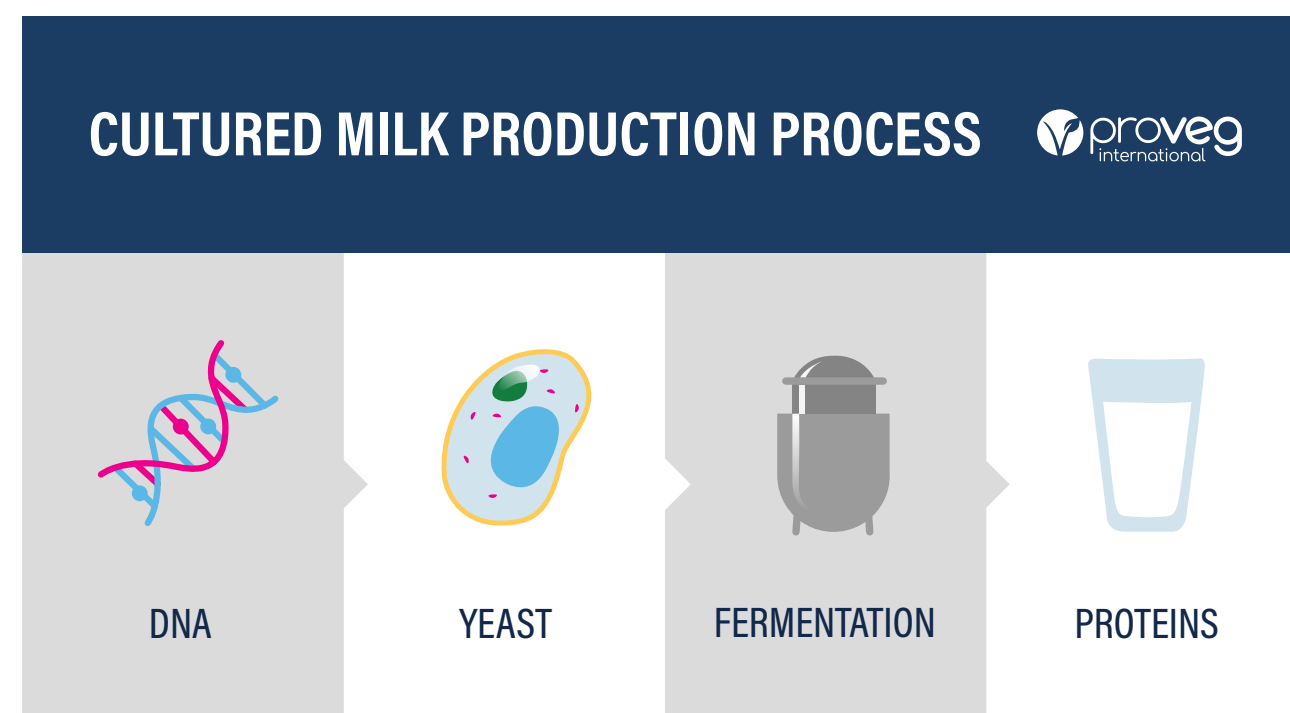
The production system perspective (approach 4) simulates how the emissions of a farm would change if dairy cows were replaced with other animals or cereals – for example, if oat milk was produced in place of cow's milk. The results of a production-system study by Rööös et al (2016) show that every scenario involving oat milk would lower GHG emissions on a Swedish farm (by 16-41%) due to reduced methane emissions from ruminants – even when the same amount of beef was produced on the farm (16-24%). Removing all the animals from the farm would decrease direct emissions by 61%. Freed-up land in all oat milk scenarios could be used to produce biogas, which could replace diesel, thus having an even more positive impact on the climate.<sup>52 48</sup>

\*(Protein, carbohydrates, fat, retinol equivalents, vitamin D, vitamin E, thiamin, riboflavin, ascorbic acid, niacin equivalents, vitamin B<sub>6</sub>, vitamin B<sub>12</sub>, folate, phosphorus, iron, potassium, calcium, magnesium, selenium, zinc, iodine)



# A LOOK INTO THE FUTURE: CULTURED MILK PROTEINS

Using an approach that is similar to the production of cultured meat, several scientists are currently working on producing lab-grown versions of the proteins that are found in cow's milk - such as casein and whey - but without the need for cows or other animals. In order to produce these animal-free dairy proteins, the genetic code of certain microorganisms, such as baker's yeast, for example, is modified, enabling them to produce milk proteins that are completely identical to those derived from animals through a fermentation process. The production process is similar to that of vanillin, a food additive often used in ice cream and pastries, or insulin, which is used by people with diabetes to control their blood-sugar levels.<sup>53, 54</sup> The starting substance is plant material that provides the yeast cells with the required nutrients such as sugar, fats, and certain amino acids.<sup>55</sup> During the fermentation process, the cells produce casein and whey that can be used in various ways.



There are several groups of researchers and startups attempting to use these proteins in various ways. Perfect Day, founded in 2014 in San Francisco by Ryan Padya and Perumal Gandhi, is partnering with food companies to develop animal-free dairy products that are more sustainable, humane, and have certain health benefits.<sup>56, 57</sup>

**”** Finding alternatives to animal proteins that have lower greenhouse gas emissions are a win-win for consumers and the planet.

**James Lomax, UN Environment's Food Systems and Agriculture Programme Management Officer, 2019<sup>58</sup>**

Real Vegan Cheese is a team of biohackers and citizen scientists belonging to two open-community labs in San Francisco. The project took part in the International Genetically Engineered Machine (iGEM) competition 2014 and won a gold medal and best-of-track trophy. The project includes contributions from students and scientists from more than 30 countries. The aim of the Real Vegan Cheese project is to create an alternative method of producing tasty, nutritious cheese that does not contain any genetically modified organisms (GMO) and is environmentally sustainable. In order to make the information accessible to as many people as possible, they are publishing all of their information and results.<sup>59</sup>

The third organisation is called New Culture.<sup>60, 61</sup> The development of their product, a mozzarella made from lab-grown dairy proteins combined with plant lipids and sugars, is still in its early stages. They are part of the eighth intake at IndieBio, a company that invests in innovative technologies for human and planetary health.<sup>62</sup> A similar project is planned by Legendairy foods. This startup from Berlin has taken part of the ProVeg Incubator and was founded in January 2019 by Raffael Wohlgensinger and Britta Winterberg. Their first prototype, also a mozzarella cheese, is scheduled to be completed in 2020. Other cultured dairy products are planned to follow.<sup>63</sup>

Animal-free dairy proteins offer a variety of advantages compared to conventional dairy products. They do not contain antibiotics, hormones, or lactose and are therefore suitable for people affected by the respective allergies or intolerances. They also provide the same nutritional value, taste, texture, and functionality as dairy protein.<sup>56</sup>

Proponents of cellular milk argue that its production requires less energy and land, and emits less greenhouse gases, and is therefore more resource-efficient than animal farming. Additionally, specific proteins can be individually produced in predefined amounts. This means that manufacturers are no longer bound by the set ratio of proteins in cow's milk and might be able to create new functional foods, as well as replacing cow's milk as the central ingredient in dairy products such as cheese and yoghurt.<sup>64</sup>

During the production process, gene manipulation is applied, which often leads to scepticism among consumers. According to Perfect Day, the modified GMOs are filtered out so that the protein itself does not contain any GMOs.<sup>56</sup> Additionally, the use of the fermentation process has already been established in other areas and is considered to be safe. Nevertheless, it is necessary to explain the production process and provide background information in order to improve consumer acceptance.



Picture by Boonchoke, Shutterstock



## NOMENCLATURE AND LEGAL FRAMEWORK

Typical 'dairy terms' are currently used to describe plant-based alternatives in many countries around the world. In countries such as China, South Africa, and India, milk alternatives based on soya are usually marketed as 'soya milk'.<sup>63</sup> However, food-labelling legislation varies from country to country. Whereas, in some countries, the use of dairy denominations for plant-based alternatives is comparatively liberal, it is more strictly regulated in others.

In the United States of America, for example, the Standard of Identity defined by the Food and Drug Administration (FDA) describes milk as "the lacteal secretion [...] of one or more healthy cows".<sup>65</sup> However, this standard has not been strictly enforced, and producers frequently use the word 'milk' to describe their plant-based dairy alternatives. The statutory authority Food Standards Australia New Zealand defines 'milk' in similar terms to the FDA. However, these standards state that the use of the term 'soya' before the term 'milk' indicates that the beverage is not a dairy product to which dairy standards apply.<sup>66</sup> Consequently, 'soya milk' is a legal sales denomination in Australia and New Zealand. In Europe, on the other hand, the use of the term 'milk' for vegan dairy alternatives is prohibited. Soya-based milk alternatives are therefore often labelled 'soya drink'. Since European law provides a particularly restrictive framework for the naming practice of plant-based dairy alternatives, a closer look will be taken.

### Terminology for plant-based dairy alternatives in the European Union

In the European Union, the legal framework for the naming of dairy alternatives is stipulated by Regulation (EU) 1308/2013 of the European Parliament and of the Council. Regulation 1308/2013 establishes the common organisation of the markets in agricultural products (CMO) and provides the legal basis for the ban of dairy names for plant-based alternatives. Annex VII, part III, of the regulation, defines the term 'milk' strictly as "the normal mammary secretion obtained from one or more milkings without either addition thereto or extraction therefrom".<sup>67</sup> It further states which products are considered to be 'milk products'. Consequently, the use of dairy sales denominations such as 'milk' or 'cheese' for plant-based alternatives is forbidden. Hence, milk alternatives are often simply labelled 'drink' or 'beverage'.

Legal disputes have arisen in the past as a result of this legislation. The lawsuit against the company Tofutown in 2017 is one of the most prominent examples. The company was sued for marketing plant-based products that carried names such as 'tofu butter'. The case ended up before the European Court of Justice (ECJ), which ultimately confirmed Regulation 1308/2013<sup>68</sup> – dairy denominations are reserved exclusively for products that contain the secretion of animals. Considering the restrictive judicial framework, the result of the legal dispute was not surprising. Even though the ECJ validated the ban, it could not provide complete clarity in the labelling practice. When product descriptions such as 'alternative to yoghurt' or 'dairy variation' were challenged on the grounds of the CMO regulation in the Netherlands, the Court of Appeal 's-Hertogenbosch ruled in December 2017 that such references are not intended exclusively for use in describing dairy products and are consequently valid.<sup>69</sup> However, the Court of Appeal of Brussels ruled in 2015 that denominations such as 'variation on dairy' are not admissible for plant-based alternatives.<sup>70</sup> Due to these diverging judicial decisions, labelling rules for dairy alternatives remain unclear.

### The case of 'coconut milk'

Even though the usage of the term 'milk' is reserved exclusively for products consisting of animals' mammary secretions, 'coconut milk' is a legal sales denomination. It is one of several product categories that are part of an exception list to Regulation 1308/2013. Decision 2010/791/EU of the Commission gives member states the right to request the inclusion of certain terms on this list.<sup>71</sup> This applies to "products, the exact nature of which is clear from traditional usage and/or when the designations are clearly used to describe a characteristic quality of the product".<sup>67</sup> As the list has not been updated for years, the results are problematic. For example 'coconut milk', 'peanut butter', and 'fruit cheese' are legal sales denominations for plant-based products in many member states. 'Soya milk' on the other hand is not.

### Revision of Regulation 1308/2013

Plant-based dairy alternatives have been on the market for decades. Over time, terms such as 'soya milk' and 'vegan cheese' have established themselves in everyday language. Hence, the usage of these terms is unlikely to mislead consumers. This is underpinned by a German study which showed that the vast majority of consumers do not confuse animal-based products with their plant-based equivalents.<sup>72</sup>

The list of exceptions has now remained unchanged for almost 10 years. As a means of keeping up with changing dietary habits, as well as the development of new market segments and evolving consumer perceptions, Regulation 1308/2013 should be revised as soon as possible. The EU Commission should, therefore, work towards extending the list of exceptions to include long-established terms such as 'soya milk', and critically evaluate the anachronistic restrictions on plant-based products.

### Tax discrimination against plant-based milk within Europe

In Europe, the consumption of vegan dairy alternatives is hampered not only by the restrictive judicial framework of the labelling practice but also by national fiscal regulations in many member states.

Value-added tax (VAT) is an indirect tax paid by end consumers on goods and services. National governments can decide on the level of the standard VAT rate and apply up to two reduced VAT rates. Dairy products often fall under the reduced VAT rate, and therefore receive an indirect subsidy, meaning that the tax authority is waiving a part of the taxes. In some EU countries, this results in fiscally favouring dairy products from animals over their plant-based alternatives. This is the case in Germany, for example, where cow's milk falls under the reduced VAT rate of 7% while plant-based milks are subject to the standard rate of 19%. Vegan milk alternatives are thus classified as luxury goods. In Italy, the disparity is even greater, with VAT ranging from 4% for dairy milk to 22% for plant-based alternatives. There are, however, some member states which apply the same VAT rate to both dairy milk and plant-based alternatives (see table 'VAT rates for dairy milk and soya milk in several European countries'). In Belgium, for instance, both products fall under the reduced VAT rate of 6%. In Ireland, dairy milk and vegan alternatives are also taxed equally and are both zero-rated. The following table shows the VAT rates for dairy milk and soya milk in several European countries.



# VAT RATES FOR DAIRY MILK AND SOYA MILK IN SEVERAL EUROPEAN COUNTRIES<sup>73-90</sup>

Country	Cow's milk	Soya milk	VAT gap
Belgium	6%	6%	none
Denmark	25%	25%	none
Finland	14%	14%	none
France	5.5%	5.5%	none
Ireland	0%	0%	none
Netherlands	9%	9%	none
Portugal	6%	6%	none
United Kingdom	0%	0%	none
Greece	13%	24%	+85%
Austria	10%	20%	+100%
Slovakia	10%	20%	+100%
Spain	4%	10%	+150%
Germany	7%	19%	+171%
Italy	4%	22%	+450%

## Concluding remarks

Since the market for plant-based dairy alternatives is steadily growing, questions about food labelling are attracting an increasing amount of attention. The EU's strict constraints on sales denominations for plant-based dairy foods are outdated and need to be critically reevaluated in order to take account of changes in consumption patterns and the developments of new markets and market sectors.

In many European countries, dairy products are fiscally favoured over vegan alternatives. In light of the far-reaching impact of the current levels of production and consumption of animal-based products on climate, health, environment, and animal-welfare, reforming the taxation policies for these products is clearly warranted.

# MARKET AND CONSUMER DATA

## Market overview

Of all the plant-based product categories, plant milk has the highest market value and penetration. In the US, in the year leading up to June 2018, sales of plant-based milk rose 9%, while sales of traditional cow's milk declined 6%, resulting in plant milks accounting for 15% of total milk sales.<sup>91</sup> In Europe, a similar story is unfolding in markets such as Germany, the UK, and the Netherlands. According to Research and Markets, revenue from the global non-dairy milk market is set to reach more than \$38 billion by 2024, growing at a compound rate of more than 14% between 2018 and 2024.<sup>92</sup> Plant milk has become a household staple in several markets and is no longer consumed exclusively by vegans and vegetarians. In fact, a study conducted by Cargill last autumn revealed that 50% of US consumers now purchase both dairy and dairy alternatives, while 43% of Europeans do the same.<sup>93</sup>



Picture by Sergey Ryzhov, Shutterstock

Companies of all sizes are increasingly tapping into the potential of the plant-based milk market, employing a number of different entry strategies to do so. The multinational food corporation Danone acquired the market-leading brand Alpro in 2016 in a bid to increase its presence in the plant-based market, while the Finnish dairy cooperative Valio launched a plant-based line of non-dairy milks and yoghurts. Elmhurst dairy farms, founded in 1925, decided to remove cows from the mix entirely, switching to completely plant-based ingredients in 2017, while Oatly bypassed cows from the beginning, using only oats, as their name would suggest, to produce a variety of plant-based dairy items. Although, compared to any other plant-based category, a

wider array of value propositions exist in the plant-based milk space, startups continue to find new niches thanks to the myriad opportunities presented by the sheer number of raw materials in the plant kingdom, each with their own unique properties. For example, peas, considered by many to be the sector's rising star, are currently being used in plant-based dairy products. The Mighty Society, Ripple Foods, and Vly Foods (a startup from the ProVeg incubator), have all brought pea-based milk to market, inspired by its impressive nutritional profile.





Picture by Afta Putta Gunawan, Pexels



Picture by Chevanon Photography, Pexels

The popularity of the various types of plant milk varies between countries, although almond tends to be most popular. In the US, almond milk had a 64% market share, followed by soya (13%) and coconut (12%).<sup>94</sup> While these three varieties dominate the US market, new varieties of dairy-free milk, such as pecan milk and quinoa milk, have seen strong growth as consumers diversify their non-dairy milk repertoire. In the UK in 2017, almond milk was also the strongest performer, with sales of \$106.9m (up 9.1%), followed by sales of soya milk of \$101.7m (up 1.3%) and coconut milk, with sales of \$34m (up 17.4%). In terms of growth, however, oat milk exceeds all other plant milks in a number of markets, owing largely to the highly successful brand, Oatly. In the UK, Oatly's second-largest market after its home market of Sweden, where it occupies 66% of the plant-based milk market, oat milk was up 66.7% between 2016 and 2017.<sup>95</sup> As supply begins to meet demand, and its benefits and sensory appeal become cemented in the minds of consumers, we can expect oat milk to stand a good chance of knocking almond milk from the top spot in this dynamic market sector over the course of the next few years.

Unsurprisingly, in light of its value and penetration, plant milk is the best represented in retail locations out of all the plant-based product categories. In the UK market in particular, the variety of high-performing plant milks has been capitalised on, with supermarkets dedicating ample shelf space to an array of divergent value propositions, which, combined with their growing presence in refrigerated shelves, ensures visibility. Placing them next to cow's milk reduces the need for behaviour change from consumers and clearly signals the products' use occasions. This, in turn, increases the likelihood of acceptance and understanding and, therefore, purchase among those who had not set out to purchase non-dairy milks, in the process expanding companies' consumer bases. In June 2017, in response to growth of 11.5% in the plant-milk category, Sainsbury's doubled its range of alternative milks in 300 of its stores<sup>96</sup>. Sainsbury's, who pursue a first-mover strategy when it comes to the stocking of iconic plant-based brands – and are even entering into exclusive distribution agreements in some cases – were the first to bring Califia Farms' products and, more recently, the Mighty Society's pea mylk to their home market as a means of attracting new segments and fostering loyalty. In Germany, although the plant-milk sector is growing strongly, it remains underrepresented, particularly in the refrigerated space, which already houses 30% of all plant milks in the UK. Moreover, the market volume of plant milk is three times larger in the UK than in Germany, clearly underlining the growth potential for new businesses operating in the plant-milk space in Europe's largest economy.<sup>97</sup>

As far as consumer satisfaction with plant milk is concerned, a study recently conducted by ProVeg in Germany and the UK, which sampled 1,004 consumers in the German

market and 663 consumers in the UK market, revealed that consumers tend to be highly satisfied with the non-dairy milk they purchase, with reducers (individuals looking to reduce their consumption of animal-based products but who still consume them) only marginally less satisfied than those who eat mainly or only plant-based foods, suggesting equal, or even superior quality, when compared to conventional dairy. 88% of German respondents were satisfied with the consistency of the plant-based milk they purchase (of which 58% were very satisfied), 87% with the taste (of which 56% were very satisfied), and 77% with the product's perceived naturalness (of which 45% were very satisfied). Although over half of respondents expressed satisfaction with the products' price (of which 29% were very satisfied), a quarter were neutral and a further 12% dissatisfied. Comparatively high neutrality could also be observed for the products' perceived nutritional value (18%), with a further 15% stating that nutritional value is not something they take into account when purchasing plant-based milks. A similar story emerged in the UK market, with 91% of respondents expressing satisfaction with the consistency of the plant-based milk they purchase (of which 66% were very satisfied), 90% with the taste (of which 65% were very satisfied), and 80% with its perceived naturalness (of which 55% were very satisfied). Again, price invited the least positivity, with 22% neutral and around 10% dissatisfied.<sup>98</sup>

Despite the high satisfaction levels compared to other plant-based food sectors, the market for plant milks is not yet saturated, particularly in light of modern consumers' thirst for novelty, experimentation, and variety, to which the richness of the plant kingdom perfectly lends itself. Moreover, in some of the other plant-based food categories, consumer education and persuasion is still required, while plant milk is already widely trusted and liked. In short, there are still various lower-risk opportunities in the plant-based sector for innovators to identify and cater to unmet needs, e.g. by pursuing a low-price strategy and/or by utilising new raw materials, especially in countries with less extensive plant-based ranges in retail but high levels of consumer openness, e.g. Germany.



## The rise of plant milk in China

Numerous factors suggest that the plant milk market in China will continue to grow in the coming years. Due to the long-established food culture of consuming soya products, the Chinese acceptance of plant milk is very high. Another important factor is that most Asian people are lactose intolerant and therefore dairy products do not generally play an important role in their diet.<sup>99</sup> At the same time, the typical Western diet is becoming increasingly popular. Considering that 1.42 billion people live in China, constituting 18.41%



Picture by destiawan nur agustra, Pexels

of the world's population, the potential of the Chinese market for plant milk is obvious.<sup>100</sup>

Nowadays, many of the major beverage brands in China have introduced plant milks (predominantly soya milk) and it has become an increasing trend. For instance, Dali Foods Group introduced Soymilk, Mengniu introduced Silk, Yili introduced Plant Selected, and Nongfu Spring introduced a plant-based yogurt range. According to Euromonitor International, the compound growth in soya-milk sales volume and revenue in the Chinese market increased by 9.3% and 12% respectively between 2014 and 2018.<sup>101</sup> It is predicted that, in the coming five years, the growth rate of soya milk sales will be twice that of cow's milk.<sup>102</sup> As of 2016, the major soya milk brands were Vita, BlueSword, and Wei Wei, with market shares of 41.42%, 26.57%, and 10.37% respectively. The growing popularity of Dali's Soymilk also shows the expanding market for soya milk.

Vitasoy posted revenue of 4.45 billion HKD (\$567.6 million USD) for the six months ending September 2018, a 22%

increase from the previous year, with Mainland China, Macau, and Hong Kong accounting for more than 90% of sales.<sup>103</sup> Fujian Dali Group has also been achieving success with the introduction of their soya milk, which has claimed 4.8% of the total soya milk market share in the two years since it was released in 2017.<sup>104</sup> In 2018, the total revenue for cow's milk beverages and so called plant-protein beverages, which include all types of plant-based milk such as soya, nut, rice, and oat, reached 197 million USD, an increase of 72% over the same period the previous year. The plant-protein beverage sector contributed a large part of this rapid revenue increase, generating 144 million USD from April to December in 2017 alone. It took only nine months for Soymilk to reach a break-even point. Dali also launched two other soya milks in 2018 (green beans and black beans), which are being sold through 1,400 different dealers, with over a million points of sale.<sup>105</sup>

Plant-protein beverages are clearly well established in China. According to a survey by The New Zealand Institute for Plant & Food Research, three quarters of consumers in China use them regularly, with 52.3% consuming plant-protein drinks a few times a week or everyday and only 5.4% of participants reporting that they do not use plant-protein drinks at all.<sup>106</sup>

## Consumer perspective – the thirst for plant milk

While total sales of cow's milk in the United States of America (USA) and Europe have been falling for years, the demand for plant milk is rising.<sup>107, 108</sup> More and more consumers are consuming fewer animal

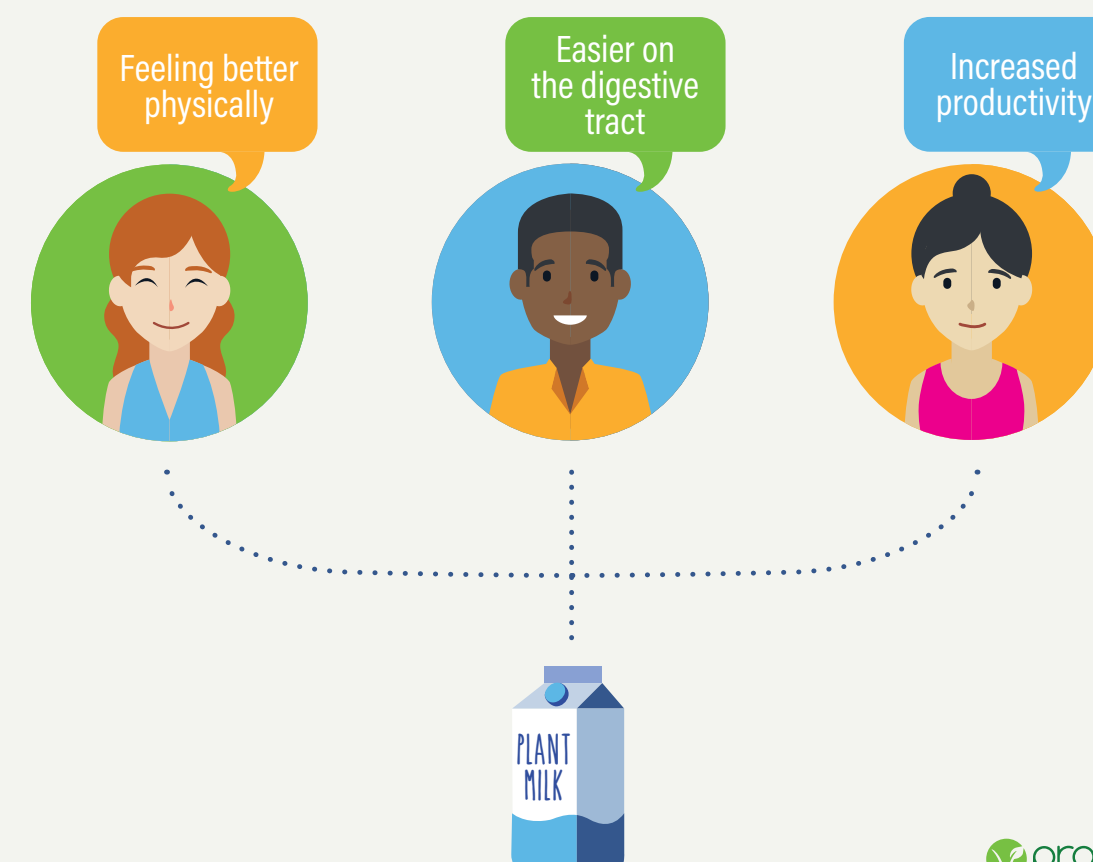
products and diversifying their diet with plant milk. According to a study on consumer behaviour and attitudes towards milk, the main drivers for choosing plant milk are good taste, health aspects, and reduced environmental impact.

When it comes to the health aspects of plant milk, fewer calories, less fat, and lower carbohydrates are the most important factors for consumers. These results support the assumption that healthier and more environmentally-friendly lifestyles are a focus for today's consumers and, as a consequence, a growing interest in plant-based foods and beverages has arisen. Also relevant for consumers of plant milk is the fact that they are often fortified with vitamins and calcium, and are naturally sweet, without the need for added sugar.

Consumers who only consumed plant milk or who combined cow's milk as well as plant milk stated that it is easier on the digestive tract, that they feel physically better, and that they have noticed increases in productivity. It should be noted that this is generally not because consumers are using plant milks to counter lactose intolerance – only 15% of respondents said they were lactose intolerant.<sup>107</sup>

## CONSUMER-REPORTED EFFECTS OF CONSUMING PLANT MILK

Either by itself or in addition to cow's milk



(McCarthy et al. 2017)

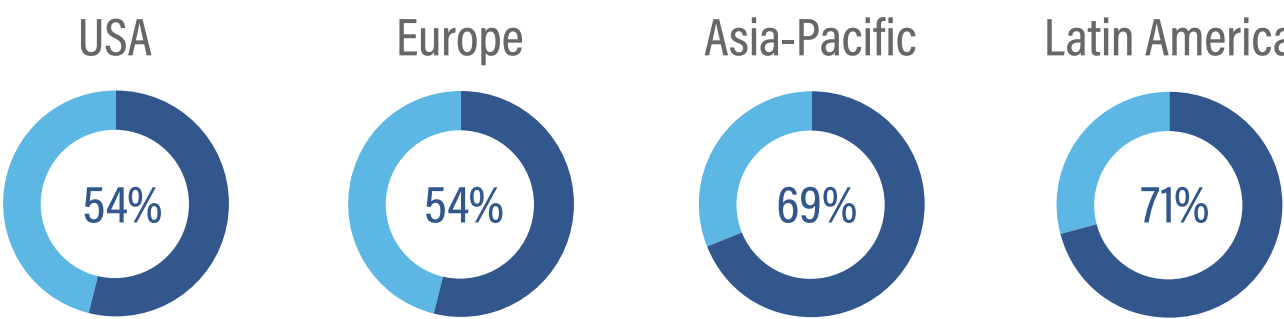
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But who are the consumers of plant milk? According to a report by Cargill, one in two American and European consumers use plant milk, either by itself or in addition to cow's milk. In Asia-Pacific and Latin America, more than two-thirds of all consumers use plant milk by itself or in addition to cow's milk. As such, the majority of plant-milk consumers are omnivores who are consciously consuming less animal products.

## CONSUMERS USING PLANT MILK

Either by itself or in addition to cow's milk



(Cargill 2018)

Among the reasons for avoiding cow's milk, health reasons such as lactose intolerance, milk allergies or sensitivities, and a reduced intake of saturated fats, cholesterol, and sugar were the most frequently cited by consumers around the world. One in three consumers from the Asia-Pacific region also stated that they did not like the taste of cow's milk, while for American and Latin American consumers, animal rights and environmental issues also played an important role.<sup>93</sup>

The decisions to purchase plant milks are made consciously, and names such as soya milk or almond milk do not lead to confusion. This is confirmed by a consumer survey by the International Food Information Council (IFIC) undertaken in 2018. While the US Food and Drug Administration claims, without empirical evidence, that consumers are confused by these labels, the IFIC sampled a thousand American consumers and concluded that, for the most part, the public does indeed understand that plant milks do not contain any cow's milk.<sup>109</sup> Consumers buy plant milks because they want to consume less animal products but, at the same time, do not want to completely change their consumption habits. It is therefore an easy way to live a healthier and more sustainable life.

### The milk alternative for farmers and dairy plants

It is not only environmental aspects that support reducing the production of cow's milk and switching to plant-based alternatives. For years, the industrial nations have been producing far more cow's milk than there is demand for. This global overproduction of cow's milk causes prices on the world market to continuously fall, leading to more and more farmers abandoning dairy farming. While milk production has increased in the last 30 years, the number of dairy farms has fallen by 63% in Australia, 75% in the USA and 81% in the EU.<sup>110-114</sup> Today, most milk is produced by industrial agricultural companies.

With 145 million tonnes of milk production in 2018, the EU is the world's leading producer of cow's milk. However, this is much more milk than Europeans actually consume. The surplus cow's milk is processed

into milk powder and exported to West Africa, where its low price point dominates local markets and hinders African farmers from attaining economic independence. This practice is strongly criticised by various organisations such as Oxfam and SOS Faim that are working for human rights and sustainable agriculture.<sup>114</sup> This means that it is not only animals and the environment that are the victims of high cow's-milk production, but also individual farmers.

The switch to the sustainable production of plant-based food can be part of a solution to these various problems. ProVeg spoke with farmer Daniel Hausmann from Germany about what such a transformation might look like. Hausmann studied organic farming and marketing and took over his father's family farm in 2012. He subsequently sold the cows and is now growing various grains and vegetables.



Picture by Hitoshi Suzuki, Unsplash

### Daniel, you have transformed your family's cattle business into a grain and vegetable farm. What led to this decision and was it difficult for you?

Even when my parents still ran it as a cattle operation, cereal farming was already part of our business. I went vegan at around the time when I took over the farm. Naturally, raising cattle had stopped making sense to me, but, because we had relatively little farmland, we needed another source of income. And since I like growing vegetables anyway, I decided to do that instead of raising cows. So we sold the cows and, rather naively, I just bought seedlings and seeds and started growing the vegetables. Particularly at the beginning, a lot of investments had to be made: for machines, foil tunnels, or vans, for example. That costs a lot of money. But the business has grown more and more and now we are where we are. At this point, we have established ourselves as a vegetable seller in the region and we are satisfied with the way things are going.

### You not only said goodbye to animal farming, you also no longer use any animal fertilisers for the cultivation of your plants. Instead, you practice vegan organic agriculture. Can you tell us what this is and how it works?

The main difference is that conventional farming uses synthetic nitrogen fertiliser. Firstly, it takes a





lot of energy to produce and distribute it. On top of that, it's easily soluble and quickly travels into the groundwater. In organic farming, this practice is abandoned, with the nitrogen instead produced by legumes. This is a special group of plants which are able to bind nitrogen from the air by using bacteria. They make it available to the plants, and thus help to build up soil fertility. In conventional organic farming, this cultivated mix of legumes and grasses is then fed to cattle. In organic vegan agriculture, we do not want to use cattle but we cannot simply leave them out – we have to replace them with something. In other words, the clover-legume mix must still be cultivated and we then have to consider what we want to do with it. In our case, we have chosen to compost it, so we compost the grown clover-legume mix and then use it as fertiliser for our fields. This plant fertiliser is no more or less effective than cattle manure, because the cow itself does not produce any nutrients but only converts the substances from the feed and makes them available as fertiliser.

Another alternative to cows would be a biogas plant. That would be a mechanical cow, so to speak, because a biogas plant does nothing more than convert waste material into usable material. The plants are fermented, releasing biogas, which can be used as biofuel for vehicles or to generate electricity and heat. And, in terms of greenhouse gas emissions, a biogas plant is more environmentally friendly than cattle farming.

**Would you also recommend that other farmers switch from animal farming to plant food production?**

It depends on the farm. If a farmer owns only cattle and grassland, that's going to be a challenge. Nevertheless, I can only recommend it in order to reduce animal suffering and protect the environment. In this context, it is often difficult to talk about animal suffering, because no matter which farmer you talk to, everyone will tell you that their own animals are doing well. So, when talking to farmers, I would opt to argue that it's a big time-saver. Because providing a really good level of care for animals costs a lot of time and energy. On the other hand, I can simply leave a plant alone once in a while, you know? And, especially when it comes to animal farming, everyone complains that it doesn't pay enough, so you might as well grow vegetables. Of course, you have to bear in mind that many farmers have made major investments and have to pay off loans, so an overnight transition is not a possibility for them. It's important to have a plan, a vision toward which the farm can develop.

One possibility would be not to invest further in animal farming, while also starting to grow plants. Plants such as vegetables, which have a high profit yield per hectare, are particularly suitable for this. Thus, relatively high yields can be achieved with manageable investments on a small area. Another option for farmers is going into landcare, which plays an important role in protecting biodiversity and is usually financed by government. Other services such as winter road clearance or the management of local forest areas also present opportunities. These are things that have to be decided by farmers on a case-by-case basis, depending on their particular farm. Each farm has to find a suitable solution, but I am sure that these solutions exist.

**Thank you for chatting to us, Daniel!**

Another example of the successful transformation from animal to plant-based products is Elmhurst Milked, LLC. The dairy was founded in 1925 and became one of the major dairy companies in New York. After years of success, and with the demand for cow's milk continuing to decline, owner Henry Schwartz decided to make a fundamental change. After 90 years in business, he closed the dairy and started a plant-milk company.

“Making plant milk might have seemed like a radical turn after a life in dairy – yet to me it was perfectly logical, probably even necessary.”

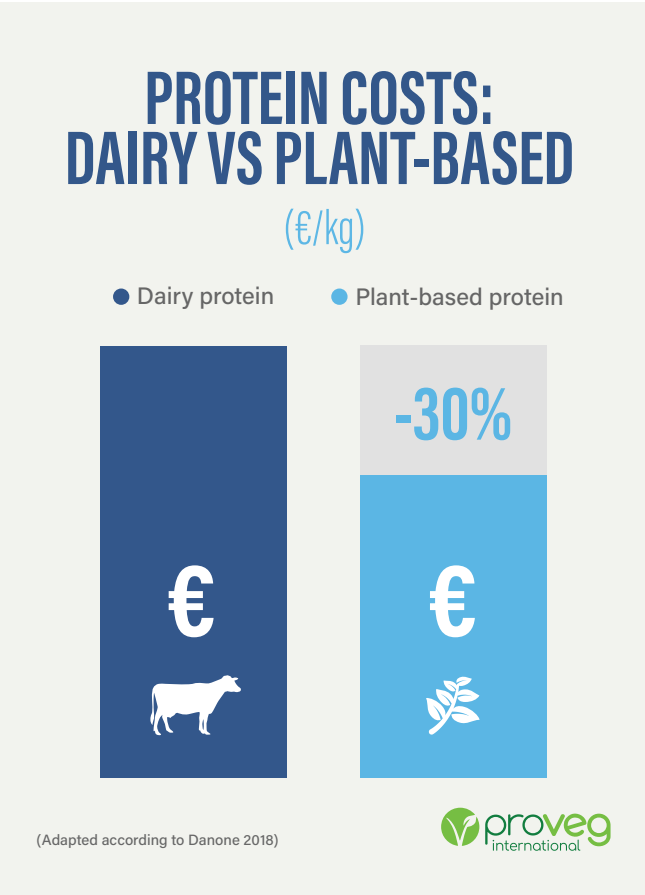
**Henry Schwartz, Owner of Elmhurst Milked, LLC.**

The shift to plant-based milks is not the only innovation in the sector. Together with food scientist Dr Cheryl Mitchell, Elmhurst has developed his own process for producing nut milk, which they call 'milking'. It is a cold-grinding process which extracts all protein, fat, and micronutrients from nuts and seeds, and then recombines them into a milk-like liquid. The nutritional profile of the original nut or seed is maintained and no gums or emulsifiers are needed to hold the product together. The company now offers 16 different products, including Walnut Milk, Barista Almond Milk,

and a Hazelnut Hemp Creamer. According to Elmhurst, today the company is the fastest growing plant-based beverage company in the US.<sup>115, 116</sup>

Even Danone, the world's largest producer of dairy products, says that plant milk is particularly lucrative because plant-based proteins are on average 30% cheaper than dairy proteins. They also cite the significant protection of resources due to the use of raw plant materials instead of cow's milk. For these reasons, Danone plans to triple its plant-based output by 2025.<sup>117</sup>

The above examples all illustrate the massive potential of plant milk for the entire food supply chain. On the one hand, resources are saved and, on the other hand, new fields of work are created.





## GOT PLANT MILK IN YOUR NUTRITION GUIDELINE?

The United Nations General Assembly has declared the period 2016-2025 to be the Decade of Action on Nutrition. In addition to ending hunger, the main goal is to ensure universal access to healthier and more sustainable diets for all people, regardless of who they are or where they live. Members and Member States are committed to improving sustainable food systems at all levels, from production to consumption, through their public policies.

Food-based Nutrition Guidelines are an important instrument here. As well as providing advice to citizens about healthy eating, they form the basis for food and agricultural policies.<sup>118</sup> In recent years, more and more countries have been integrating sustainability aspects into their food policies and consumer-education programmes. The FAO points to the important socio-political relevance of the Nutrition Guidelines and sees them as a powerful instrument for promoting sustainability in the field of nutrition. They should therefore contain specific recommendations for consumers and promote sustainable food decisions. As an example of such recommendations, the FAO cites first and foremost a mostly plant-based diet.<sup>119</sup>

“There is increasingly robust evidence to suggest that dietary patterns that have low environmental impacts can also be consistent with good health – that win-wins are possible, if not inevitable.

**Food and Agriculture  
Organization of the United  
Nations, 2016<sup>118</sup>**

Although 75% of the world's adult population is lactose intolerant, many guidelines recommend consuming cow's milk. In countries where the consumption of animal food is too high anyway, cow's milk is often a single food group that the guidelines recommend should be consumed daily. But there is no evidence to support this recommendation.

As a result, in 2019, Canada dropped the 'milk' food group from its updated guidelines and instead lists cow's milk in the protein group, which also includes fortified soya drinks, pulses, nuts and seeds, and other animal-based products such as meat and fish.

Daily consumption of cow's milk is no longer recommended and instead a higher consumption of plant proteins is recommended.<sup>120</sup> An official statement from the Canadian Government says: “The guidelines are based on the best available scientific evidence. They promote healthy eating and overall nutritional well-being, and support improvements to the Canadian food environment.”<sup>121</sup>

Finally, due to the high CO<sub>2</sub> emissions and the large amount of land and water used in the production of cow's milk, there is an urgent need to include sustainable and healthy alternatives in national nutrition guidelines. Since milk has become part of everyday life for many people, the use of plant milk helps to enable a healthy, balanced diet and, at the same time, reduces food-related environmental impacts, without them having to change their eating habits.

ProVeg wanted to know which countries have already integrated plant milk into their dietary guidelines and which have not. To this end, we evaluated a collection of guidelines from 92 countries in 25 different languages, available on the FAO website.<sup>122</sup> If there was no guideline available for a country, the summary provided by the FAO was used. Due to language barriers, the guidelines of six countries\* could not be evaluated. For these countries, the FAO summary was also used. In addition, we also evaluated the Russian guideline, which was not available from the FAO.<sup>123</sup> Only guidelines that apply to an entire national population were examined, so we have not included guidelines for specific target groups.

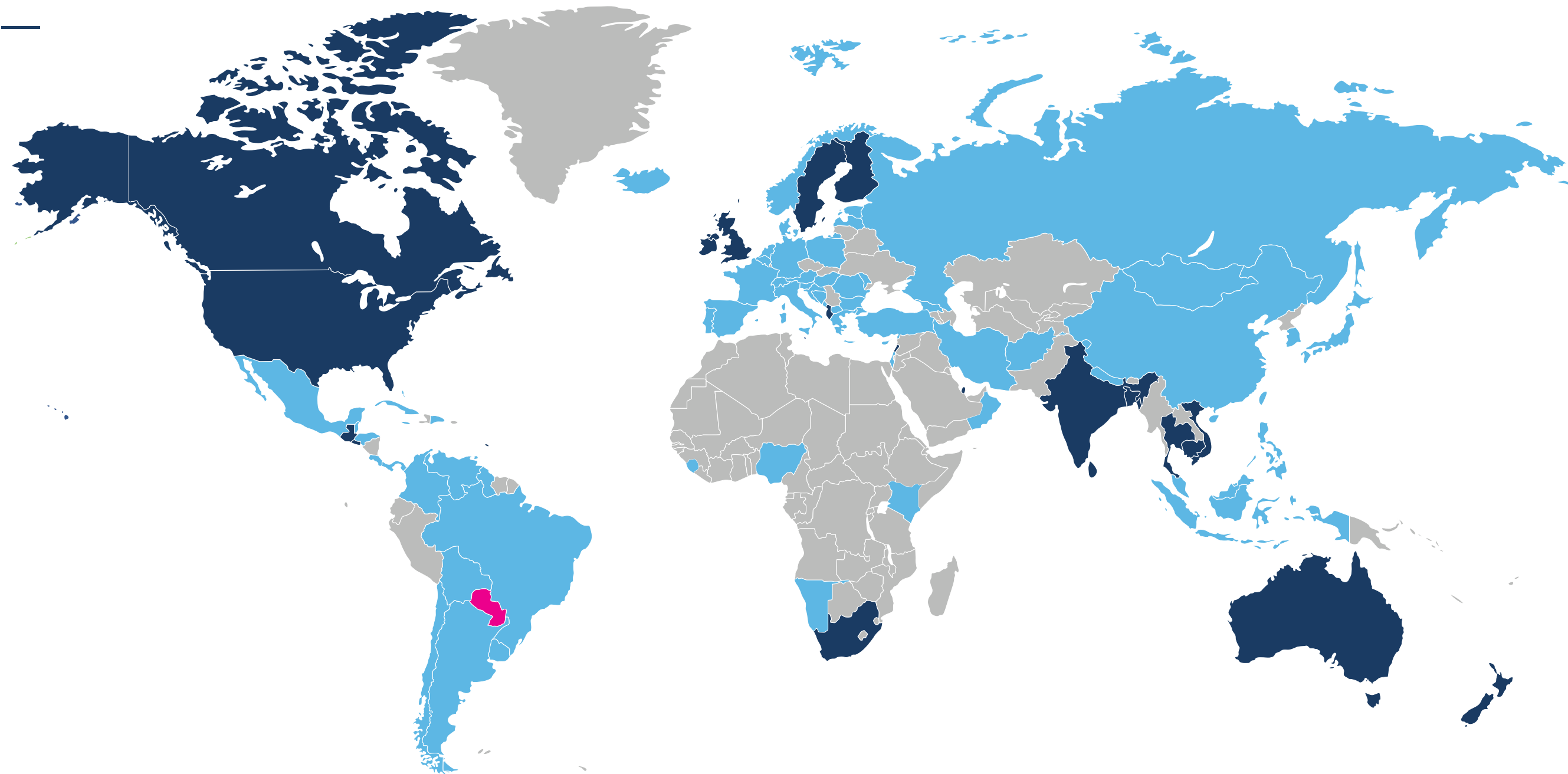
### Results

A total of 23 countries mention plant milk as an alternative to cow's milk in their guidelines. The remaining countries don't mention it at all, while just one country (Paraguay) rejects plant milk as an alternative to cow's milk.

\*Indonesia, Croatia, Estonia, Romania, Slovenia, and the former Yugoslav Republic of Macedonia



# PLANT MILK IN NATIONAL NUTRITION GUIDELINES



- Countries which recommend plant milk as an alternative to cow's milk
- Countries which do not mention plant milk at all
- Countries which do not recommend plant milk as an alternative to cow's milk
- No data available





Plant milk is most commonly recommended as an alternative for people with lactose intolerance and cow's milk allergy, as well as for people who follow a plant-based diet. All 23 countries mentioned (fortified) soya milk. Other types of plant milk which are mentioned include oat, nut, and rice milk. In the following table, we collected statements from several countries:

Country		Statement
	South Africa	"Vegans should consider including fortified foods that contain vitamin B <sub>2</sub> and B <sub>12</sub> . To increase the content of these vitamins in the diet, it is important to eat plenty of yeast extract, soya milk, and breakfast cereals."
	Fiji	"Reduce drinking fizzy drinks and other sugary soft drinks – drink fresh water, fresh coconut juice, unsweetened fruit juice, low fat or soya milk instead."
	New Zealand	"Choose some low-fat milk products (e.g., green or yellow label milk, low-fat yoghurt) or milk alternatives with added calcium (eg, soya or rice milk with added calcium)."
	Thailand	"Soymilk is a soybean product that provides protein, vitamins and minerals which are useful to the body. Regular intake of soymilk is also advised"
	Vietnam	"Encouraging producing tofu and soya milk as one of valuable protein from plant which biologically help prevent cardiovascular-disease and cancer."
	Sweden	"Enriched plant-based drinks made of wheat and soy have a lower climate impact than dairy products."

Country		Statement
	United Kingdom	"There are a number of alternative foods and drinks available in super-markets to replace the milk and dairy products you [lactose intolerant people] need to avoid. Food and drinks that do not usually contain lactose include: soya yoghurts and cheeses, coconut-based yoghurts and cheeses, almond milk, yoghurts and cheeses, rice milk, oat milk, hazelnut milk, foods with the 'dairy-free' or 'suitable for vegans' signs."
	Barbados	"Use skimmed or 1% low fat milk and other low fat dairy products. Soy and almond milk can also be substituted for whole milk."
	El Salvador	"Soymilk is an excellent substitute for cow's milk because it contains proteins and calcium and can be offered as refreshment to school-children."
	USA	"Soy beverages fortified with calcium, vitamin A, and vitamin D, are included as part of the dairy group because they are similar to milk based on nutrient composition and in their use in meals. Other products sold as "milks" but made from plants (e.g., almond, rice, coconut, and hemp "milks") may contain calcium and be consumed as a source of calcium, but they are not included as part of the dairy group because their overall nutritional content is not similar to dairy milk and fortified soy beverages (soymilk)."
	Paraguay	"It is important to know that consuming a cup of soya juice, also misnamed "soya milk", is not the same as drinking a cup of cow's milk, because soya juice does not contain the necessary amount of nutrients, mainly calcium, to cover the body's needs. Therefore, soy juice cannot replace milk consumption."



# ProVeg recommendations

This report shows how successfully plant milk has been established in recent years, as well as its potential for the establishment of a globally healthy sustainable diet. Since milk has become part of everyday life for many people, the use of plant milk helps to enable a healthy, balanced diet and, at the same time, reduces food-related environmental impacts without people having to change their eating habits. This is a great opportunity.

ProVeg recommends that national governments include plant milk as an alternative to cow's milk in their nutrition guidelines. ProVeg also calls on governments to allow the use of the term 'milk' for plant milk in order to make purchasing easier for consumers. Characteristics such as the use, texture, and taste of the alternative products can be determined at first glance by the use of 'milk terms.' At the same time, there is no risk of misleading the public as it is in the interest of all parties to clearly indicate that the product is plant-based. The plant-based characteristics are also often a clear motivation to purchase.

The tax discrimination that exists in some countries must come to an end. The tax rate for plant milks should at least be the same as for cow's milk – or even lower due to the reduced environmental impact. For the sake of animals and the environment, ProVeg also recommends that farmers and dairy companies convert their businesses to alternative plant-based models. This approach can produce rich dividends for companies in purely economic terms, as the examples of Elmhurst and Danone show. It is also recommended that manufacturers of convenience products use plant-based alternatives instead of cow's milk powder and other animal-based ingredients. ProVeg supports companies in switching to plant-based production.

It is also recommended that the retail trade and restaurant sector include plant milk in their selection if they have not already done so. Plant milk is purchased by the majority of consumers and not only by special target groups such as vegans or allergy sufferers. In Asia, Africa, Australia, the Americas, and Europe, plant milk is a part of everyday life for many people. Here, too, ProVeg supports companies with the introduction of more plant-based products.

ProVeg recommends that consumers choose unsweetened or only slightly sweetened plant milk for a healthy, balanced diet. In addition, the use of plant milk varieties enriched with calcium is recommended. Since there are differences between the numerous brands and variants, on-pack nutritional information should be always compared. For consumers, plant milk can be a healthy and environmentally-friendly alternative to cow's milk. Adding more variety to one's diet and reducing one's individual environmental footprint. ProVeg supports consumers with the necessary information on plant milk, as well as with recipes to make their own delicious plant milk at home.



Picture by Dani Rendina, Unsplash

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