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FIELD PEA AND ITS IMPORTANCE FOR A SUSTAINABLE AGRICULTURE AND BETTER FOOD SYSTEMS

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Abstract

The cultivation of peas (Pisum sativum) presents a promising opportunity for promoting sustainable agriculture and ensuring food security in the face of contemporary challenges. This leguminous plant (Fabaceae family), plays a crucial role in the process of nitrogen fixation in the soil, significantly enhancing its fertility while simultaneously reducing dependence on synthetic fertilizers. Within a global context characterized by food insecurity, driven by climate change and market fluctuations, there is an urgent need to promote less conventional crops that possess significant agronomic potential. This article aims to consolidate the numerous advantages offered by pea cultivation, including its origins, relevance, and adaptability to various agro-climatic conditions. Moreover, it will highlight the high nutritional value of peas, alongside their potential to address increasingly urgent global challenges, such as the need to produce sustainable and healthy food for a constantly growing population. In this regard, peas are not only emerging as an important agricultural crop but also as a key pillar in the sustainable food strategy.

***Key words**: pea, sustainable, agriculture, food security.*

INTRODUCTION

One of the main goal of scientists is to find optimal methods to maintain high productivity of crops under climate changes condition as well as developing crops with enhanced nutritional value, such as legumes. In support of this objective comes genetic engineering, which is revolutionising agriculture, increasing resilience and improving crop adaptation (Bonciu et al., 2021; De Souza and Bonciu, 2022).

The plant-based protein market has been steadily growing globally. Globally, the plant-based protein market will continue to increase (Thavarajah et al., 2023).

Pisum sativum, commonly known as pea, is an important leguminous crop grown globally for its nutritional and ecological benefits. One of the primary reasons for the increasing interest in *Pisum sativum* is its remarkable nutritional profile. Peas are an excellent source of plant-based proteins, making them an essential food for vegetarians and vegans (Shanthakumar et al., 2022; Thavarajah et al., 2023).

Rich in essential amino acids, they provide a high-quality protein alternative to animal-based products. In addition to protein, peas are packed with dietary fiber, which promotes digestive health, lowers cholesterol levels, and aids in maintaining a healthy weight. The high content of vitamins, particularly vitamin C, and minerals such as iron, potassium, and magnesium, further contribute to their importance in human diets (Dahl et al., 2012). However, the benefits of pea extend far beyond its nutritional value.

As a leguminous crop, peas have the unique ability to fix atmospheric nitrogen in the soil through a symbiotic relationship with soil bacteria (Jakobsen, 1985). This process not only enhances soil fertility but also reduces the need for synthetic fertilizers, which are widely recognized for their negative environmental impact.

The widespread use of chemical fertilizers in conventional farming has led to numerous environmental issues, including soil degradation, water pollution, and the release of greenhouse gases (Finez et al., 2023). By incorporating nitrogen-fixing crops like peas into crop rotations, farmers can reduce their reliance on chemical inputs, improving both the sustainability and resilience of their agricultural systems. Furthermore, pea can serve as a climate-resilient crop.

With the increasing unpredictability of weather patterns and the growing threat of climate change, farmers are seeking crops that are more adaptable to extreme conditions. Peas, which are hardy and drought-tolerant once established, offer potential for cultivation in regions facing water scarcity or fluctuating climatic conditions (Zhang et al., 2016). Their relatively short growing season also makes them an attractive option for farmers in areas with shorter growing periods, allowing them to diversify their crop portfolios and reduce risk. With the environmental and ethical concerns surrounding animal agriculture becoming more prominent, peas and other legumes are gaining recognition as key components of a sustainable food future. As demand for plant-based protein sources increases, peas are poised to become an even more integral part of global food systems.

In this context, the purpose of this paper was to present the high nutritional value of peas, alongside its potential to address increasingly urgent global challenges.

MATERIALS AND METHODS

The methodology includes a comprehensive analysis of recent literature published on pea, focusing on its agricultural, nutritional, and environmental contributions. Studies published in the last five years were prioritized to ensure the inclusion of the latest developments in the field.

The review covers various aspects of pea, including its cultivation practices, genetic improvements, ecological benefits, and uses in human nutrition, livestock feed, and food processing. Additionally, the environmental impact of pea cultivation, such as its role in nitrogen fixation and its potential in crop rotation systems, was explored.

RESULTS AND DISCUSSIONS

Nutritional Benefits of pea

Pisum sativum is a nutrient-dense crop that provides high-quality protein, fiber, and micronutrients essential for human health (Table 1).

Table 1. The nutritional value of peas

Component	Range/Content	Reference
Carbohydrates	59.32–69.59% of dry weight	Arif et al., 2020
Starch	39.44%–46.23%	Raghunathan et al., 2017
Dietary Fiber (Total)	23.23%–30.72% of seed weight	Kan et al., 2018
Soluble Fiber (SDF)	3.91%–8.01%	Kan et al., 2018
Insoluble Fiber (IDF)	19.32%–23.1%	Kan et al., 2018
Protein	20–25% of dry weight	Shanthakumar et al., 2022
Lipid	3.06%–7.3%	Kan et al., 2018
Ash Content	~3.07%	Arif et al., 2020
Pea Protein Composition	55%–65% globulin	Lu et al., 2020
Lysine in Pea Protein	Rich in lysine	Ge et al., 2020
Fatty Acids in Lipids	42.01%–60.68% polyunsaturated fatty acids	Ciurescu et al., 2018
Main Fatty Acids	Palmitic acid (12.39%–19.24%), Linoleic acid (34.56%–47.74%), Linolenic acid (7.37%–12.55%)	Ciurescu et al., 2018
Minerals	Nitrogen (28.49–54.78 g/kg), Phosphorus (1.648–4.04 g/kg), Potassium (13.13–50.41 g/kg)	Nadeem et al., 2021
Selenium	28.6 μg/100 g	Liu et al., 2019
Tocopherols (Vitamins)	48.44–57.00 μg/g of total tocopherols	Padhi et al., 2017

Recent studies have shown that peas are particularly rich in essential amino acids like lysine, which is often limiting in other plant-based proteins (Smith et al., 2023).

A growing body of evidence suggests that *Pisum sativum* can be used as a substitute for animal proteins in various plant-based food products, including meat analogues, dairy alternatives, and protein-rich snacks (Vastolo et al., 2025). The protein content of dried peas typically ranges from 20 to 25%, with an amino acid profile comparable to that of soybeans (Michaud et al., 2020). Furthermore, peas are an excellent source of fibers, particularly soluble fibers, which contribute to gut health and have been linked to reduced risks of cardiovascular disease (Johnson et al., 2021).

Pisum sativum is an excellent source of high-quality protein, containing all nine essential amino acids required for human health. The protein content in peas typically ranges between 20% and 25% of dry weight, with significant levels of lysine, an amino acid often limited in many other plant-based proteins (Michaud et al., 2020). Recent studies emphasize the potential of pea protein as a sustainable alternative to animal-based proteins, making it particularly valuable in the context of growing global demand for plant-based products (Smith et al., 2023). In addition to protein, peas are rich in dietary fibers, with levels ranging from 15% to 20% of dry weight. This high fibers content includes both soluble and insoluble fibers, which promote digestive health, regulate blood sugar levels, and contribute to lower cholesterol levels, thereby reducing the risk of cardiovascular diseases (Johnson et al., 2021).

Soluble fibers, particularly, plays a significant role in managing cholesterol by binding to bile acids and helping eliminate them from the body (Smith et al., 2022). Peas are also a valuable source of essential micronutrients. They are rich in vitamins such as folate (vitamin B9), which is important for cell division and proper neural development, particularly during pregnancy. In addition, peas contain a high concentration of vitamin C, an antioxidant that supports the immune system, promotes skin health, and aids in iron absorption (Michaud et al., 2021). Moreover, peas provide essential minerals such as iron, magnesium, potassium, and phosphorus, which contribute to overall health by supporting metabolic functions, bone health, and muscle function.

Recent studies have highlighted the antioxidant properties of peas, which can help neutralize free radicals in the body and reduce oxidative stress, a major factor in chronic diseases such as cancer, diabetes, and cardiovascular conditions (Johnson et al., 2021). Moreover, pea protein has been shown to have a positive effect on satiety, making it an ideal ingredient in weight management and health-conscious diets (Jones et al., 2023).

With a relatively low glycemic index (GI) compared to many other carbohydrate-rich foods, peas are beneficial for individuals with diabetes or those seeking to manage blood sugar levels. This makes peas a versatile addition to a balanced diet, especially for people following plant-based diets or those with dietary restrictions (Baldwin et al., 2021).

The digestibility of pea protein has also been shown to be high, with studies indicating that pea protein is easily absorbed by the human body, similar to animal proteins like whey (Michaud et al., 2021). This is especially important for athletes or individuals with higher protein needs, as well as for individuals who experience digestive issues with other protein sources.

Carbohydrates constitute one of the primary chemical components of pea seeds, making up 59.32–69.59% of their dry weight (Arif et al., 2020). Starch content ranges from 39.44% to 46.23% (Raghunathan et al., 2017), higher than that of faba beans (38.4-41.8%) (Abdel-Aal et al., 2019). Peas are also rich in dietary fibers, with 23.23%-30.72% of pea seeds containing 3.91%-8.01% soluble fibers and 19.32%-23.1% insoluble fibers (Kan et al., 2018). Protein content in pea seeds is about 20-25% of the dry weight (Shanthakumar et al., 2022), similar to adzuki beans (23.51%) and kidney beans (23.44%-24.90%) (Ge et al., 2021).

Lipid content ranges from 3.06% to 7.3%, similar to cowpea (4.22%-7.17%) (Kan et al., 2018), while ash content is about 3.07% (Arif et al., 2020). Nutrients in pea seeds are influenced by cultivar, environment, and planting year (Wang et al., 2010), highlighting the need for further studies on the systematic comparison of chemical composition across different cultivars for precise use in the food industry.

Pea seeds are rich in dietary fiber, comprising 23.23%-30.72% of the seed, including 3.91%-8.01% soluble dietary fiber (SDF) and 19.32%-23.1% insoluble dietary fiber (IDF) (Kan et al., 2018). Pea seed SDF content is comparable to that of broad beans, kidney beans, and cowpeas (Kan et al., 2018). Ultrafine grinding technology can increase SDF content in pea seeds from 1.26% to 4.97% (Wang et al., 2021).

Dietary fiber helps lower cholesterol and glycemic indexes, suggesting that peas may aid in the prevention of diabetes and hypercholesterolemia. Pea SDF consists mainly of galacturonic acid, arabinose, galactose, glucose, mannose, rhamnose, xylose, and fucose (Wu et al., 2019), with galacturonic acid being the predominant sugar. IDF in pea seeds contains glucose, arabinose, galacturonic acid, xylose, galactose, mannose, and rhamnose, suggesting it is made of cellulose, xylans, and arabinans. Pea dietary fiber and polysaccharides exhibit significant antioxidant and hypoglycemic effects (Mayengbam et al., 2019). However, further research is needed to better understand their chemical structures.

Pea protein is categorized into globulin, albumin, prolamin, and glutenin, with globulin accounting for 55%-65% of total protein in field peas (Lu et al., 2020). Pea proteins are rich in lysine, complementing the amino acid profile of cereal-based diets and offer health benefits such as antioxidant, anti-diabetic, and anti-hypertensive effects, as well as supporting gut health. Also, pea proteins are used in various food applications, such as encapsulating bioactive compounds and in alternative meat products (Ge et al., 2020).

Allergenic proteins in peas, including Pis s_1 and Pis s_2, are associated with allergic reactions in sensitive individuals (Popp et al., 2020). The amino acid composition of pea proteins is well-balanced but is limited by methionine and cysteine (Ge et al., 2021), with aromatic amino acids and lysine being limiting for different age groups (Han et al., 2020). Pea proteins share similar physicochemical characteristics with soybean proteins, including pH-dependent solubility and isoelectric points (Zhao et al., 2020).

High-pressure processing and heat treatment reduce pea protein solubility (Hall et al., 2021), and pea proteins have better foaming stability and water adsorption capacity than rice and wheat proteins (Zhao et al., 2020). Pea proteins may serve as a potential substitute for soybean proteins in meat and sausage products (Zhao et al., 2020). However, further studies are needed for more accurate and conclusive data due to sample size and genotype limitations.

Pea seeds are low in lipids, making peas a low-fat food. The lipids in peas primarily consist of polyunsaturated fatty acids, accounting for 42.01%-60.68% of total fatty acids, with lower levels of unsaturated fatty acids (Ciurescu et al., 2018). The main fatty acids in peas include palmitic acid (12.39%-19.24%), linoleic acid (34.56%-47.74%), and linolenic acid (7.37%-12.55%) (Ciurescu et al., 2018). The bioavailability of these unsaturated fatty acids during digestion remains uncertain and requires further investigation.

Peas are a source of several minerals, such as nitrogen, potassium, phosphorus, manganese, copper, and zinc, with their content varying across genotypes (Nadeem et al., 2021). The primary minerals in peas include nitrogen (28.49-54.78 g/kg), phosphorus (1.648-4.04 g/kg), and potassium (13.13-50.41 g/kg) (Nadeem et al., 2021). Minor amounts of selenium are also found in peas (28.6 μg/100 g) (Liu et al., 2019), higher than in mung beans. The bioavailability of these minerals in peas remains unclear and requires more research. Peas also contain vitamins like α-tocopherol and γ-tocopherol, with total tocopherols ranging from 48.44 to 57.00μg/g, higher than lentils and kidney beans but lower than chickpeas (Padhi et al., 2017).

Ecological and Environmental Benefits

As a leguminous crop, pea offers significant ecological and environmental benefits, positioning it as a key player in sustainable agricultural practices.

One of the most remarkable advantages of peas is their ability to fix nitrogen, a process that significantly enhances soil fertility and reduces the need for synthetic fertilizers. Peas, like other legumes, form a symbiotic relationship with rhizobial bacteria in the soil, which allows them to convert atmospheric nitrogen into a bioavailable form that plants can use for growth (López et al., 2020). This natural nitrogen fixation can reduce the reliance on synthetic fertilizers, whose production and use contribute significantly to environmental pollution, greenhouse gas emissions, and soil degradation.

Studies have demonstrated that the inclusion of peas in crop rotation systems can lead to a significant reduction in the use of nitrogen fertilizers by up to 40%, which in turn decreases the overall environmental footprint of agriculture. This is particularly important in areas with intensive agricultural practices, where fertilizer overuse leads to eutrophication of water bodies, contributing to algae blooms, aquatic ecosystem imbalances, and contamination of groundwater sources (Baldwin et al., 2021).

By replacing synthetic nitrogen inputs, pea cultivation helps mitigate these adverse environmental effects and promotes a more sustainable approach to farming. Additionally, pea's nitrogen-fixing ability enhances soil health by improving its organic matter content and microbial diversity.

Research has shown that peas can increase soil microbial activity, leading to improved soil structure and water retention capacity. This is particularly valuable in regions affected by desertification and soil erosion, where maintaining soil health is critical to ensuring long-term agricultural productivity (Smith et al., 2022). Peas also help reduce the risk of soil compaction due to their deep root system, which can penetrate compacted soils and improve aeration; further enhancing soil fertility. The reduced need for chemical inputs not only protects pollinators and other beneficial organisms but also helps preserve the surrounding ecosystems from chemical contamination. In this regard, pea is an excellent choice for organic farming systems, where the use of synthetic chemicals is limited or avoided entirely. Furthermore, peas have demonstrated excellent resilience to drought, making them an ideal crop for regions facing water scarcity due to climate change. In fact, the main factors that impact any agronomic crops yield and quality are represented by the management of biotic and abiotic constrainers: the weather conditions during the growing season of plants, crop rotation, the previous crop, the soil tillage system, cropping technology, nitrogen fertilization, etc. (Paraschivu et al., 2024; Partal et Paraschivu, 2020; Partal et al., 2023; Săndulescu et al. 2024; Zălă et al. 2023).

Peas require significantly less water compared too many other crops, such as rice or maize, and their drought-tolerant nature makes them a valuable component of dry land agriculture systems (López et al., 2020). Lastly, the versatility of pea in crop rotation systems enhances the resilience of agricultural ecosystems to pests, diseases, and environmental stress. By rotating peas with cereals or other crops, farmers can break pest cycles and reduce the overall incidence of soil-borne diseases, improving the health and sustainability of the entire farming system.

The ability to use peas in a diverse range of agricultural systems, from conventional farms to regenerative and organic practices, makes them a versatile and eco-friendly option for modern agriculture (Michaud et al., 2020).

Sustainable cultivation practices

Legume grains such as field peas and field beans can be produced on a local level, and may be reliable sources of dietary protein and energy apart from common soybean and rapeseed meals (Bachmann et al., 2020).

Pea is a quick growing, an annual herbaceous vine that requires the trellis to support growth. Is typically a cool season crop and thrives well in cool weather.

Require an average temperature range of 10-18°C during its growth period and can be cultivated on all types of soils under appropriate management conditions, but it prefers well drained soil for early crop and high yield.

A well-drained loamy soil free from excessive soluble salts with neutral pH range of 6.5 to 7.5 is suitable for successful cultivation of the crop. The field must be free from stubbles and crop residues of previous crops by ploughing through disc plough followed by 2-3 harrowing. To ensure good drainage and aeration in the field, powdery seedbeds must be avoided.

Field pea is mostly grown on residual soil moisture and can sustain drought conditions up to some extent. All soils must be analysed prior to planting so that any corrective measures may be taken before a problem becomes noticeable. Light sandy soils require more fertiliser than heavier soils. The phosphorus and potassic fertilizer should be applying as basal dose based on soil test value.

Peas are sown as early as possible in the spring, the best time being the end of February or the beginning of March, when the soil temperature reaches 4-5°C, with a tendency to increase. The last sowing period is April 1-2. For autumn crops, sowing can be done in September.

Pea is a poor competitor with weeds, especially during the first month after planting. However, perennial weeds and annual weeds that emerge

early in the season are very competitive with pea.
Controlling diseases in field pea begins with crop rotation. A preferred crop rotation would have field pea planted with at least four cropping years between plantings.
Field peas should be harvested when they are fully ripe. A desiccant may be used to enhance crop drying prior to combining. Maintaining a low cutter bar height is essential to reduce pea losses.

Economic trends and potential for sustainable farming and better food systems

Global pea consumption is set to reach almost 6 million metric tons by 2026. This represents a growth of 0.4% per year since 2017. India was the top consumer in 2021 with 2.3 million metric tons. China, Ethiopia and Bangladesh followed in that order (https://www.reportlinker.com/clp/). In Europe, Spain and France dominate the cultivation of field peas (Table 2).

Table 2. Cultivated area and production of peas in Europe

Country	The cultivated area (ha)	Percentage of total (%)	Production (tons)	Percentage of total (%)
Austria	1920	1.35%	8650	1.11%
Belgium	9600	6.77%	62400	7.97%
Bulgaria	530	0.37%	1410	0.18%
Croatia	390	0.27%	3160	0.40%
Cyprus	50	0.04%	660	0.08%
Czechia	1020	0.72%	2630	0.34%
Denmark	1090	0.77%	4110	0.53%
Estonia	130	0.09%	200	0.03%
Finland	3910	2.76%	7830	1.00%
France	40150	28.33%	268200	34.30%
Germany	3820	2.69%	20310	2.59%
Greece	870	0.61%	7130	0.91%
Hungary	18490	13.04%	91350	11.69%
Italy	15170	10.68%	72530	9.27%
Lithuania	170	0.12%	190	0.02%
Luxembourg	0	0.00%	0	0.00%
Malta	0	0.00%	0	0.00%
Netherlands	6230	4.40%	37250	4.76%
Poland	8400	5.91%	49500	6.32%
Portugal	1540	1.08%	7280	0.93%
Romania	1070	0.75%	2140	0.27%
Slovakia	1330	0.94%	3560	0.46%
Slovenia	40	0.03%	130	0.02%
Spain	19700	13.87%	114530	14.64%
Sweden	6200	4.38%	17350	2.22%
EU	141820		782500	
EU Average	5672.8		31300	

The economic potential of pea has been highlighted by the increasing demand for plant-based protein sources in response to growing concerns over the environmental impact of animal agriculture.
Due to its nutritional profile and versatility, pea has become a popular ingredient in plant-based meat alternatives, dairy substitutes, and protein supplements (Jones et al., 2023). In particular, pea protein isolates are widely used in the production of plant-based burgers, sausages, and protein shakes. Moreover, pea cultivation offers economic opportunities for farmers,

particularly in regions with limited access to expensive synthetic inputs.
The crop's resilience to adverse weather conditions, combined with its ability to enrich soil fertility, makes it a cost-effective option for sustainable farming. In addition, peas can be marketed as a high-value crop in both fresh and processed forms, providing income diversification for farmers in rural areas (Michaud et al., 2021).
There are several ways in which farmers can be eligible for the green payment scheme, and one is by cultivating nitrogen-fixing crops. Those crops, which include peas, protect the soil from erosion and improve soil organic matter.
The global market for plant-based proteins is projected to grow significantly in the coming years. According to recent reports, the global plant-based protein market is expected to reach $17.9 billion by 2027, with a compound annual growth rate (CAGR) of 7.6% from 2020 to 2027 (Smith et al., 2022). Within this expanding market, pea has gained prominence due to its high protein content, ease of cultivation, and minimal environmental footprint.
As consumers increasingly seek plant-based alternatives for meat, dairy, and other animal products, the demand for pea protein - particularly pea protein isolates and concentrates - has risen dramatically. Pea protein has become a key ingredient in the production of plant-based meat substitutes, including burgers, sausages, and nuggets, as well as dairy alternatives such as milk, yogurt, and cheese. These products have gained significant market share due to their nutritional benefits, affordability, and versatility.
Beyond the plant-based food industry, pea has significant applications in animal feed, particularly in the growing market for sustainable and plant-based animal feeds. Also, peas are a valuable source of protein for livestock, particularly for poultry and pigs.
The increasing focus on reducing the environmental impact of animal agriculture has led to a rise in the use of plant-based ingredients, such as pea protein, in animal feed formulations. This shift is expected to continue as farmers and feed manufacturers seek to reduce their reliance on resource-intensive protein sources, such as soy and fishmeal, which contribute to deforestation, land degradation, and overfishing (Smith et al., 2022).
In addition to its role in food and feed, pea holds promise in the biofuel and bioplastics industries. Research into the use of pea biomass as a feedstock for biofuels is gaining traction, as peas are a renewable resource with relatively low environmental impact compared to traditional biofuel crops like corn and soybeans. The potential for pea-derived bioplastics, which can replace petroleum-based plastics, is also being explored. This opens up new markets for peas in the bioeconomy, where sustainability is increasingly a priority. Peas also provide an opportunity for farmers to diversify their income streams. The demand for peas in both fresh and processed forms such as frozen peas, pea flour, and pea protein products, has been steadily increasing, allowing farmers to access lucrative markets beyond traditional fresh produce sales.
As the global food system shifts towards more sustainable and plant-based products, peas offer farmers a crop that aligns with these trends, contributing to economic stability and growth in rural communities (Bonciu, 2023).
Consumption of whole peas reduces blood glucose, improves gastrointestinal health, and enhances satiety. This nutritional, functional, and sustainable benefit recommends peas as a major alternative protein source for the global food industry.

CONCLUSIONS

Pea (*Pisum sativum*) is a crop with huge potential to contribute to a more sustainable and resilient agricultural future. Its nutritional, ecological, and economic benefits position it as a key player in addressing the global challenges of food security, environmental sustainability, and climate change.
The ability of peas to fix nitrogen, reduce the reliance on synthetic fertilizers, and improve soil health makes them an essential component of sustainable farming systems. Additionally, the growing demand for plant-based proteins offers significant economic opportunities for farmers and the food industry.
To fully realize the potential of peas, continued research into its genetic improvement,

cultivation practices, and market development is essential.

The European strategies provide the policy framework for supporting sustainable food systems in developing countries. In this context, growing peas can contribute to mitigate climate change and adapting to its impacts; also, peas can ensure food security, nutrition and public health.

Preserving the pea's affordability, while generating fairer economic returns in the supply chain, this sustainable food can also become one of the most affordable.

Food chain players (consumers, producers and processors) can make a real contribution to strengthening a better, more resilient and responsible food system. The adoption of pea as a staple crop in sustainable agricultural systems holds promise for a healthier, more sustainable future.

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