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Assessing the Role of Rabbits in Circular Food Systems: A Review

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Abstract

Rabbits are gradually gaining attention as effective players in circular food systems mainly because they can manage resource and nutrient waste, minimize waste, and improve food quality. This review discusses the diverse areas in sustainable agriculture where the rabbit plays a part because of its efficiency in feed conversion to produce high-quality protein. The paper reviews published literature to establish that rabbits are versatile animals regarding the husbandry practices they can be subjected to or the ability to feed on kitchen wastes and agricultural residues. The research findings reveal that rabbit manure can be an excellent organic manure for soil and crops. In addition, the potential for rabbit farming as an economic enterprise of smallholder farmers and urban farming is discussed. Several consequences of integrating rabbits into local food systems are analyzed, especially concerning the problems of feeding the world's population and the availability of resources. This review highlights possible future studies to improve rabbit husbandry and, further, the role of rabbits in food security.

Keywords: Climate smart production, Circular food systems, Food security, Rabbits, Resilience, Sustainable agriculture,

Introduction

A circular food system is now recognized as one of the most innovative cases for furthering the sustainable agriculture concept while promoting efficiency in the use of resources, minimal waste production, and cyclical production cycles. While the linear food system is a model that includes the extraction of resources, consumption of products, and disposal of wastes, the circular system entails the cycling of organic matter so there are no wastes but nutrients to be recycled (Könninger et al., 2021). These systems are increasingly appreciated as critical to meeting global demands

for food, water, and energy, mainly due to climate change and the continually growing demand for food worldwide.

The role of rabbits in circular food systems does not only end with providing proteins. With nitrogen, phosphorus, and potassium in their manure, the herbivores act as natural organic manure sources, boosting permaculture health and lowering synthetic manure utilization (Wang et al., 2022) Rabbits can also easily fit into an animal- crop production system with complementary production,

such as fish farming and poultry production (Kitavi et al., 2016). For these reasons, rabbits are suitable for smallholding farmers, urban farming projects, and restricted resource areas. Besides, since they multiply quickly and have small space needs, they can be grown in many locations desynchronized from centralized food processing centers, providing a solution to the protein deficit in rural and urban settings.

This review sought to give a perspective of rabbits in circular food systems and more so in efficiency, waste reduction, and economic and environmental sustainability. The review outlines some studies and rabbit farming cases that help improve food security globally alongside sustainable agricultural methods. The discussion also

provides an understanding of constraints to the rabbit farming business, such as disease control, market access, and perception. Lastly, the review suggests how to enhance rabbit farming and promote it as an enterprise in varied agricultural settings to enhance the agenda of sustainable food systems.

Production and Trade

The overall world rabbit production is estimated at 570 million rabbits and hares slaughtered and this produced 860,000 Tonnes of (Table 1) and was valued at US\$ 1.5 billion (FAOSTAT, 2021). Table 1. Shows the regional share of this production with Asia, mainly China leading with 53.1% (FAOSTAT, 2021)

Table 1. Rabbit and hare meat production globally and in various world regions

Region	Region Rabbit and hare meat production 2021 (Tonnes)	Share of global rabbit and hare meat production 2021 (%)	Rabbits and hares slaughtered 2021 (thousand head)	Share of rabbits and hares slaughtered 2021 (%)
World	861,739	100.0	572,120	100.0
Asia	597,147	69.3	378,380	66.1
Europe	150,773	17.5	98,746	17.3
EU (27)	118,836	13.8	83,877	14.7
Africa	98,360	11.4	82,083	14.3
Latin America*	15,460	1.8	12,911	2.3

Source: FAOSTAT (2021)

Resource Efficiency

Rabbits are among the most economical animals regarding feed conversion rate and floor space requirement. The feed conversion ratio (FCR) is interesting; rabbits need only three kilograms of feed to make one kilogram of body weight, which is much more efficient than cattle, which need eight kilograms of feed, and pigs need six kilograms of feed (Oseni & Lukefahr, 2014). This efficiency lowers feed requirements and minimizes agricultural resource use for producible feeds, which helps in the sustainability of food production. Rabbits are heavy consumers of cellulose on feed sources that man will otherwise perceive as unfit for human consumption: forages, crop residues, green vegetables, and vegetative materials (Lukefahr & Oseni, 2021). Using those byproducts, they turn worthless biomass into quality protein (Nistor et al., 2013) and simultaneously help combat food waste. This ability resonates with the circular food system, where waste hardly is thrown away.

In size, rabbits are small and need very little space for their dwelling, and this makes them appropriate for almost any type of farming, especially in built-up areas or on the edge of towns. Due to high population density, farmers can practice rabbit production in backyards, rooftops, or small confined places, indicating localized and space-efficient meat production (Nigussie, 2017). Another advantage of its use is its ability to be reproduced quickly (Dalle Zotte & Szendrő, 2011). Mating occurs in the morning, and rabbits take thirty days to gestate, so if they give birth to six to eight kits, rabbits will grow in number frequently, which makes it possible to have an adequate supply of protein. Compared to cattle or pigs, which have maturation cycles of months and years, rabbits are a faster and more efficient way of meeting growing protein needs.

Moreover, rabbits are less environmentally radioactive than conventional meats of cattle and other livestock in terms of outputting greenhouse gases and using water and space. This efficiency makes them an environmentally friendly or climate smart system for sustainable agriculture, especially in constrained or arid environments (Gidenne et al., 2017) and therefore makes them resilient. These attributes enhance the position of rabbits in feeds as a key commodity in circular economy protein production systems.

Waste Reduction and Nutrient Cycling

Rabbit farming forms a central component of circular food systems, especially regarding waste minimization and nutrient cycling. Rabbits can eat almost all organic feed leftovers, such as vegetables, fruit peels, and agricultural residues that would otherwise be dumped in the landfill. These ingredients are converted into high-quality protein through rabbit farming, which helps avoid food wastage and the emission of greenhouse gases when organic wastes decompose. The most significant value of rabbits is probably in their droppings, which are cold compost and can be utilized directly on the ground. Rabbit droppings are, therefore, a good organic manure containing nitrogen, phosphorus, and potassium, which are fertility-boosting nutrients in the soil for increased crop production (Königer et al., 2021). Evaluations made on the use of rabbit manure on farms have shown that farm yields and vegetation have improved through the addition of rabbit manure, and there was less utilization of chemical fertilizers, hence reducing more impacts on the environment.

Symbiotic systems enhance the impact of rabbit farming as it concerns nutrient cycling. Rabbit dung can feed forage crops in other livestock or fishponds to improve water nutrients and support plant growth. Such practices lead to the development of lopes where waste from one process becomes material for another process in a cycle that makes overall business a more sustainable process (Hassoun, 2024). Through waste mitigation and nutrient cycling, rabbit farming is an ideal example of circular agriculture, where organic waste is converted into valuable inputs

and resources while creating a regenerative and environmentally sustainable (Camillus et al., 2023) means of farming and high value food production.

Economic Viability

Rabbit farming is highly lucrative and has many prospects, especially among smallholder producers and urban farmer entrepreneurs. As it demands little capital investment and resource enhancement before the exercise of distribution, it is cheap and feasible for farmers with little capital base (Mutsami & Karl, 2020). Rabbits are lighter animals that can be raised in less space, in comparatively small cages, and consume comparatively inexpensive feedstuffs; this way, economically strangled populations can also engage in rabbit farming for food production.

Their short reproductive period is another attribute that makes rabbit breeding economically reasonable. Due to a gestation period of about 30 days and an average litter size of eight kits, and hence eight reproductive or kindling cycles per year, rabbits can enable the investor to earn his or her returns within a short time. Such short cycles mean farmers can earn money by providing a consistent meat supply throughout the year (Dalle Zotte & Szendrő, 2011). In addition, rabbit farming is portable, and it can suit demands for the produce by quickly expanding or downsizing to meet any market requirement, making it possible as both a subsistence and business activity.

Rabbit farming is advantageous to urban farmers because rabbits can be produced in confining areas where the farmers live, such as backyards, rooftops, balconies, and agricultural tracts in urban communities. For instance, samples of the urban rabbit farming models in Africa (Matthew et al., 2023) and South America enhance the household income level and augment food security (Mutsami & Karl, 2020, Mukaila, 2023). In the Nigerian study, it was revealed that rabbit farming supported more than 80% of employment creation, household food, and improved livelihoods (Matthew et al., 2023). Additional to meat production, rabbits have other economic benefits in that their wastes, such as feces, can be sold as organic farm inputs. This additional income source provides another avenue for profitability, thereby making rabbit farming sustainable in the economy (Camillus et al., 2023, Matthew et al., 2023, Mukaila, 2023).

Integration with Other Agricultural Practices

Rabbits can easily fit into the agri-food chain, increasing the farm productivity. It can feed on different forages to control the weeds effectively, thus acting as a forage crop that can eliminate the use of herbicides. Furthermore, new disguised forms of farming, like putting rabbits at the top of the hen houses, are observed; chickens can process rabbit droppings, contribute to soil quality, and conserve resources (Sikiru et al., 2020). Such measures enhance resilience in farms and, at the same time, foster biological diversity in agriculture production systems. Rabbits are easily fitted into mixed farming enterprises with birds/ fishes or crops and/or other animals/ crops as the two complement one another regarding resource use. For instance, rabbit manure can be used for crop production, particularly crops grown in interleaving or crop animal production systems. Besides, they can also be used as a substitute for fishmeal as protein sources for aquaculture feeds.

Rabbits in Food Production and Security

Rabbits are fast gaining appreciation as the best fit for solving food insecurity challenges worldwide and even in developing nations. They are efficient feed converters and, thus, are among the best types of protein foods; they also reproduce at a very high rate. It takes rabbits a month to give birth and produces litters of six to eight kits, which makes rabbits reproduce in large numbers to feed the increasing human population searching for more proteins (Kitavi et al., 2016). Rabbit farming is used in areas that experience a meat shortage, and other animal farming is not feasible due to limited resources. Unlike big animals, rabbits adapt well to substandard land; they feed on forages, crop remnants, and other food wastes principally because they feed on cellulose products. This flexibility prevents rabbit farming from interfering with the human food chain, thus solving the problem of competition for resources common in livestock production.

In addition, rabbit meat can be a recommended source of protein with high values, as well as the reduction of fat and cholesterol. It fits nutrition in addressing malnutrition and enhancing dietary diversities for volunteers, especially those of vulnerable ages. For rabbits as livestock, the option has the potential to provide solutions to the hunger issue and boost food security in both rural and urban areas (Mutsami & Karl, 2020). Due to its low cost, effectiveness, and eco-friendly nature that enhances food security, rabbits are significant in enhancing the breakdown of food insecurity and nutrition worldwide today.

Health and Nutritional Benefits

Rabbit meat is rich in easily digestible protein, polyunsaturated fatty acids (PUFAs), vitamins, and minerals (such as calcium, magnesium, potassium, iron, cobalt and zinc), as well as being low in fat, sodium, and cholesterol, which makes it of good edible and nutritional value, so it needs to be handled properly. It also contains valuable omega-3 fatty acids which make it an excellent food for consumption (Li S et al., 2018). The benefits of consuming rabbit meat for human health are clear because rabbit is a lean meat with low cholesterol level, in addition to high levels of unsaturated fatty acids (Abd-Allah and Abd-Elaziz, 2018). This makes it a valuable source of nutrition, particularly for individuals looking to maintain a healthy diet. The California breed of rabbits had a slightly different amino acid composition, with lysine, leucine, phenylalanine, histidine, valine, threonine, isoleucine, and methionine (Morshdy et al., 2022a).

Table 2 presents a comparative nutritional composition of rabbit, chicken, beef, and pork meat. The table highlights key parameters such as moisture content, protein levels, fat content, ash content, and essential minerals like calcium and phosphorus. This comparison allows for an understanding of how these meats stack up against each other nutritionally.

Table 2: Comparative nutritional composition of Rabbit, Chicken, Beef and Pork Meat.

Parameter	Rabbit	Chicken	Beef	Pork
Moisture (g/100 g)	68.5 ± 1.05	68.1 ± 1.19	53.2 ± 1.21	43.7 ± 2.13
Protein (g/100 g)	21.2 ± 0.79	20.1 ± 0.27	26.3 ± 0.16	27.3 ± 0.22

Fat (g/100 g)	9.2 ± 0.38	10.8 ± 0.08	19.6 ± 0.09	28.2 ± 0.13
Ash (g/100 g)	1.1 ± 0.08	1.0 ± 0.05	0.9 ± 0.07	0.8 ± 0.11
Calcium (mg/100 g)	21.4 ± 0.09	12.1 ± 0.04	10.9 ± 0.38	9.3 ± 0.47
Phosphorus (mg/100 g)	347 ± 0.26	252 ± 0.06	179 ± 3.62	176.4 ± 3.36
Sodium (mg/100 g)	40.5 ± 0.89	71.4 ± 0.92	63 ± 0.90	67.3 ± 0.91
Cholesterol (mg/100 g)	56.4 ± 0.92	68.3 ± 2.14	114.5 ± 11.68	108.4 ± 10.31

Source: Nistor et al., (2013).

<https://www.researchgate.net/publication/290214524> Nutrient Content of Rabbit Meat as Compared to Chicken Beef and Pork Meat [accessed Dec 31 2024].

Rabbit meat is very healthy in that it is low in fat, contains high-quality proteins, and can be used as a substitute for beef, pork, or poultry, among others (Nistor et al., 2013). Compared with other meats and animal products, it has a richer protein content, with a mean value of 20–21%, but low fat and cholesterol, and thus can be recommended to people who need low-energy and low-cholesterol diets (Etukudo, et al., (2024). It has a very slim rendering, which is ideal, especially for populations with elevated rates of cardiovascular ailments, since it helps encourage the consumption of healthier foods.

According to Mutsami et al. (2019) and Etukudo, et al., (2024), like other meats, rabbit meat has many macronutrient and micronutrient compositions, including the B12 vitamin, iron, and phosphorus; these nutrients are essential for energy, red blood cell synthesis, and ‘building’ bones, and therefore, rabbit meat can be invaluable in supplementing diets where essential nutrients are lacking or where people need an additional boost, such as the less privileged members of society. This, coupled with the bland flavor of rabbit meat and the versatility of cuts, make this meat a perfect delicacy. Due to its increasing health benefits, people are becoming aware, and the market opportunities are opening up with more markets focusing on sustainable (Camillus et al., 2023, Mukaila, 2023) and healthier protein sources (Dalle Zotte & Szendrő, 2011). Through fighting malnutrition, increasing the diversity of dinner plates, and adjusting to the increasingly popular legislation of healthy nutrition, rabbit meat has become an appropriate option for local and international markets.

The Environmental Benefits of Rabbit Farming

Compared to conventional livestock farming, rabbit farming has substantial environmental benefits. Compared to the bigger animals that produce many greenhouse gases, need much land, water, and feed, and take much longer to grow and mature, rabbits offer more advantages (Cesari et al., 2018). It also has a high feed conversion ratio, thereby cutting on the input in terms of resources, making it sustainable for protein production.

While other herbivores, like ruminants, are believed to contribute prominently to methane production, rabbits contribute little to greenhouse gases. All these reduced impacts make rabbit farming environmentally friendly, especially when combating climate change. Also, rabbits can adapt to poor-quality lands, and food ingredients humans do not consume. This flexibility means that rabbit farming can harness such non-profit lands for animal rearing without straining other better-performing soil types (Biagini et al., 2021). Rabbit manure can also be used for regenerative agriculture. Rabbit dung is organic and nutrient-rich and supports soil health, increases carbon stocks in the soil, and tends to decrease the use of

chemical fertilizers. By recycling rabbits in diversified farming systems, farmers can improve the biological quality of the environment, reduce the output of unwanted by-products, and produce more from less.

Conclusion

Conclusively, rabbits can provide a fascinating perspective on improving sustainability in circular food systems. Their ability to convert feed into quality protein and feed on agricultural residues and food waste makes them ideal protein sources compared to traditional lives.

Furthermore, rabbit farming adopted economically makes a good prospect for business-minded small-scale farmers and potential urban farmer organizations. This is particularly important because rabbits can be reproduced easily and at minimal costs, meeting income and food security needs at the individual, parish, national, and international levels. This is aided by the nutritional value (Nistor et al., 2013) of these products, making it possible to fulfill the new and rising market trends advocating for healthy and environmentally friendly meats.

While striving to build a more adaptive system for feeding the growing global population, it is high time to reconsider the role of rabbits. Therefore, more research and policy efforts should be directed at enhancing positive rabbit production and marketing, increasing people’s knowledge of the benefits of rabbit production, and ensuring that rabbits are produced in different forms of farming. Such opportunities exist in rabbits, which should help develop a sustainable agriculture regime since increasing food demand will increase.

Conflict

The authors are in agreement to submit the manuscript for publication and it is not being considered for another journal.

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