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Economic Sustainability Foraging Scenarios for Ruminant Meat Production—A Climate Change Adapting Alternative

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Abstract: Climate changes affect all agricultural production systems, directly or indirectly, including that of ruminant meat, through the limitation of forage resources sensitive to reduced water regimes and drought. The present paper assessed the economic sustainability of ruminant meat production in the context of climate change, with a particular focus on integrating bioeconomy principles through the use of drought-resistant crops such as sorghum and millet in livestock feed. This study included scenarios for two farm-level models, a sheep fattening farm and a cattle fattening farm, to determine the economic benefit and impact of integrating resilient crops in the total feed ration. The findings showed that the dry scenario system could offer economic and environmental advantages over traditional water-intensive crops like maize. The results demonstrated that replacing maize with sorghum or millet could result in a reduction in feed costs and enhanced economic benefit over the traditional feed system.

Keywords: meat; sheep; cattle; climate change; economic sustainability

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1. Introduction

Climate change is exerting substantial pressure on global agricultural systems, with increasing temperatures, changing precipitation patterns, and more frequent extreme weather events [1,2]. The consequences are impacting both crop yields and livestock production. In the European Union and Romania in particular, the agricultural sector is a fundamental sector of the economy, being a major contributor to the gross domestic product [2]. Agriculture is an extremely vulnerable sector in Romania since it is highly dependent on climatic conditions. As a result, farmers' livelihoods are seriously endangered, especially those managing small subsistence farms [3,4].

Regarding the livestock sector, the reduced availability and quality of forages have made the maintenance of productivity and profitability a difficult task [3]. Public expenditure and policy changes are being discussed all over the EU, aiming to seek solutions for adaptation of the agricultural production methods in order to overcome the challenges and provide resilience and sustainability [5]. As the sheep and beef sectors are experiencing pressures due to climate change, such as influences on physiological processes, on production and welfare, as well as through changes in the availability and quality of forages [6], new approaches, such as integrating drought-tolerant crops and applying resource efficiency principles integrated within the bioeconomy, are expected to make a significant contribution to agricultural viability and reducing the environmental footprint [6].

Climate change could affect both meat production and meat quality by reducing nutritional intake. The impact varies across regions due to differences in climate and agricultural conditions [1]. Adequate nutrition is essential for weight gain in ruminants, and forage is an essential component of ruminant nutrition. As forage quality varies greatly from one forage crop to another and nutritional needs vary between animal species, providing adequate feed for ruminants requires a balance [5]. Adaptation to current environmental and climate conditions in animal husbandry varies from technological solutions to changes in the management or structure of agricultural holdings, based on analysis of local or regional conditions. The adaptation of agricultural holdings aims to increase productivity, based on the current knowledge and experience of farmers. It will be necessary to pay attention to the stability and resilience of agricultural production and the income of farmers in vulnerable areas. Diversification of agricultural activities and sources of income, changes in the structure of agricultural holdings, and additional investments could also become necessary [4].

Meat is one of the main sources of protein for human consumption, being composed of amino acids, vitamins, minerals, etc. with nutritional properties [7]. At the same time, beef and sheep meat are of particular importance in traditional European and Romanian cuisine. Extreme weather conditions can lead to a reduction in the number of animals, affecting the level of production costs and the availability of meat. The European sheepfarming sector is facing market difficulties that affect both economic performance and long-term sustainability [8]. Small ruminant farming on the European continent is also facing competitiveness challenges caused by the partial decoupling of direct production payments and changes in the quality of life in rural areas [9].

Cereal productivity can be affected by climate change by lowering biomass, reducing plant quality, changing sowing or harvesting periods, etc. [10]. Thus, the provision of reduced feed both quantitatively and qualitatively determines both the failure to achieve the planned meat production indicators and the decrease in meat quality, but it even affects the vital functions of the animals.

Sorghum is considered the world's fifth most important cereal crop, judging by volume of production as well as area cultivated. Sorghum is used as a source of energy and protein, both in the feed of ruminants and nonruminants [11,12]. It is the cereal crop recording the highest levels of drought tolerance and is considered the 'camel of the crops' [13,14]. It has an energy content similar to that of corn, successfully replacing it in the feeding rations of ruminants that have an increased tolerance to moderate concentrations of food tannin [11]. However, considering the experiments in the case of cattle indicate a feed conversion of approximately 10% lower compared to those diets based on corn, in the case of sheep, the conversion was only 5%, and the replacement of 100–400 g/kg of corn with the same amount of sorghum protected the animals from parasite infection (*H. contortus*), and the color and quality of the meat were improved compared to the same diets based on corn [15–17]. It has also been shown that the introduction of tannins present in several forage plants (*L. corniculatus* and *sulla*) in ruminant diets [17], has beneficial effects on wool quality, milk production, reproductive performance, and body weight [18].

Moreover, the sorghum crop is ideal for the sustainability of the agro-food system. Considering the growth of the population leading to greater demand for food, the impoverishment of the soil in nutrients, and the loss of biodiversity, the sorghum crop could represent one of the insufficiently used and often neglected food resources that might be reconsidered [19,20].

The benefits of using sorghum and millet as fodder alternatives to green corn in raising cattle and sheep are multiple and have sustainability characteristics, such as being resistant to extreme climates, being sustainable for arid and semi-arid areas and for soils with a low degree of fertility, providing nutrients with a high protein and energy content, having a low need for inputs, having lower costs for fertilizers or pesticides, showing resistance to pests, etc. [21]

Previous research has shown that sorghum silage as a substitute for corn silage is a successful alternative in areas where corn cultivation is insecure. Sorghum grains can replace those of corn, barley, or wheat. In climate and soil conditions considered optimal for sorghum and millet, the maize suffers and is poorly productive.

Millet is a highly nutritious crop for health benefits in livestock and possesses the capacity for high yields with low input. Millet, especially pearl and finger millet varieties, has gained favor for its animal feed potential on account of nutrient composition and hardiness against adverse conditions. Further, finger millet has the potential for bioethanol production to be used as nutritious food with antioxidant properties, hence qualifying it for the title 'crop of the future' [22,23]. According to Hassan et al. (2021), millets are proximately rich in protein, dietary fiber, and micronutrients, hence promising from the perspective of nutritional relevance as alternatives to maize, particularly under semi-arid conditions with restricted water and poor fertility [24]. This nutritional profile makes it particularly beneficial for improving livestock health and productivity, especially in resource-limited settings [25].

Experiments in the tropical areas of India have indicated that the residues of sorghum and millet crops meet the requirements of cattle feed in most animal breeding systems [20]. The studies carried out to compare millet grains with corn and sorghum indicated that millet can be introduced into the diet of cattle for meat, but the diets must be formulated in such a way that a larger amount of protein from this cereal can be efficiently used as a replacement for additional protein [26]. Another study that investigated the feeding behavior of sheep and goats, fed randomly with corn, sorghum, and millet, highlights that the digestibility of crude protein in millet feed was higher compared to other feeds [27].

For example, it can be used in broiler diets at inclusion rates of at least 50% without compromising performance and egg laying. More importantly, in Brazil, it is being increasingly adopted as a cover crop in no-till soybean production systems due to its positive effect on soil health and nematode infestation [28]. Other studies also emphasized the value of millet for enhancing feed efficiency towards improved productivity in livestock. Indeed, inclusion of millet into animal feed may result in various positive impacts on nutrient utilization and general health status. According to Ganapathy et al. [29], including millet in animal feed might be very beneficial in terms of improvement in nutrient utilization and overall health. Therefore, millet is promising as a crop for enhancing productivity and sustainability in ruminant production in climate change-vulnerable areas, generally due to its hardiness under environmental stresses coupled with nutritional benefits.

Sustainability scenarios for ruminant meat production presented in this paper especially emphasize the economic aspects of the sustainability of the field, which ensures the continuity of meat production in conditions of climate change by applying nutritional interventions.

This research investigates how integrating bioeconomy principles into agricultural practices can mitigate the impacts of climate change on ruminant meat production by promoting the use of resilient, resource-efficient crops like sorghum and millet. The aim was to emphasize the benefits of using these two crops in a transition towards bioeconomy, surpassing their statute of underutilized crops.

For achieving this, several key research questions (RQ) were explored to address the economic sustainability of ruminant meat production under climate change within a bioeconomy framework as follows:

RQ 1: How can the integration of drought-resistant crops such as sorghum into animal feed impact the profitability of ruminant farms?

RQ2: How does the inclusion of millet in livestock diets affect the overall productivity and economic sustainability of ruminant farms under drought-prone conditions?

RQ3: What are the overall economic benefits of replacing water-intensive crops like maize with resilient alternatives in feed rations?

RQ4: How can forage alternatives contribute to a reduction in meat production decline in conditions of climate change?

Addressing these questions will provide a good understanding of the role of resilient agricultural practices in enhancing both economic and environmental sustainability in the livestock sector. Moreover, optimizing feed inputs will enhance the adoption of circular economy principles in resource management and improve the long-term sustainability of animal husbandry operations in the face of climate-induced challenges.

2. Materials and Methods

Considering the need to reduce the economic vulnerability of ruminant farms facing climate change, as well as the sensitivity of Romanian fodder systems to drought, economic calculations of the profitability of the use in feeding for young sheep and cattle for fattening were developed, with the use in rations of some crops less dependent on the summer water regime, such as millet and sorghum.

Scenarios were built and calculations were elaborated for 2 farms framed into medium size classes, as follows: (i) young sheep for a fattening farm with 1000 heads, with the initial weight of the animals of 15 kg/head, a final weight of 40 kg/head, and an average daily gain of 200 g/day/head; (ii) a farm of 100 young cattle for fattening, with an initial weight of 100 kg/head, a final weight of 450 kg/head, and an average daily gain of 1000 g.

For the establishment of the fodder rations, the energy norms nutritive unit meat (UNC) and digestible protein (PDI), developed by specialists from the Institute of Animal Biology and Nutrition of Romania, were considered for each species, depending on the weight of the animals and the average daily gain. In the case of young sheep for meat, for an average daily gain of 200 g and the life weight at sale of 40 kg/head, animal nutritionists recommended norms of 1.23 nutritive unit meat (UNC) and 100 g digestible protein (PDI) per day. For young cattle for fattening, for an average daily gain of 1000 g and life weight at sale of 450 kg/head, the norms were 7.60 nutritive unit meat (UNC) and 562 g digestible protein (PDI) per day.

The fodder rations used for young sheep for fattening contain sorghum silage, maize silage, alfalfa hay, corn grains, barley grains, and sunflower meal, the fattening period being 140 days, from 12 to 40 kg live weight, generally during May–September. For young fattening bulls, the fattening period lasts one year; in the warm season, the feed is made with alfalfa hay, green millet, sunflower meal, and barley grains; and in the cold season with alfalfa hay, millet silage, sunflower meal, and corn grains.

The summer ration is that in the warm seasons, and the winter ration refers to the cold period of the year. The two types of fodder rations cover the entire period of the year.

Apart from sorghum and millet, as resilient fodder, administered in different forms in fodder rations, the other types of fodder also used, such as alfalfa hay, sunflower meal, and corn and barley grains, as classic fodder, are included to cover the nutritive requirements of the rations. The role of millet and sorghum is to replace the lack of corn when it is supplied in reduced quantities due to periods of drought.

Elaboration of estimates and budgets of revenues and expenses was based on the specific average technological allocations of inputs (feed, energy, medicines, other material expenses, the cost of labor, other fixed expenses, etc.) for each species and on average free market input prices. Optimizing production factors was part of the strategy to increase economic efficiency in conditions of competitiveness and environmental limitations [30].

The income and expenditure budgets were based on determining different categories of costs and incomes and estimating profitability. The value of production was determined by multiplying the unit price by the average production yield. Total costs were calculated by summing variable and fixed costs. Variable costs were determined by summing the costs with forages, biologic material costs, energy costs, medicines, other materials costs, supply costs, and insurance costs. Fixed costs include labor costs, general costs, interest rates, and amortization. Taxable income was determined by the difference between the value of total production and total production costs. In total, 10% of taxes have been deducted from taxable income, resulting in net income. Rate of return (%) was determined by dividing taxable income by total costs for the main production.

Based on the relations known from the economic literature, technical–economic and risk indicators of the activity were calculated according to the following formulas:

$$TC = VC + FC,$$

where

TC—total costs, VC—variable costs, FC—fixed costs

$$VC = Fc + bc + ec + mc + oc + sc + inc,$$

where

Fc—forage costs, bc—biologic material cost, ec—energy cost, mc—medicines cost, oc—other materials costs, sc—supply cost, and inc—insurance cost

$$FC = lc + gc + ic + ac,$$

where

lc—labor cost, gc—general costs, ic—interest rate, and ac—amortization cost

$$VP = VM + VS,$$

where

VP—value of production, VM—value of main production, and VS—value of secondary production

$$TI = VP - TE,$$

where

TI—taxable income, VP—value of production, and TE—total expenses (total costs)

$$NI = TI - t$$

where

NI—net income, TI—taxable income, and t—taxes

$$RR = TI/CM$$

where

RR—rate of return, TI—taxable income, and CM—costs for main production

$$MC = Fc + bc + mc + oc,$$

where

MC—material costs, Fc—forage costs, bc—biologic material cost, mc—medicines cost, and oc—other materials costs

$$P = Up - Pc,$$

where

P—profit, Up—unitary price, and Pc—production cost

$$MVC = VP - VC,$$

where

MVC—margin on variable costs and VP—value of production

$$VC = Fc + bc + ec + mc + oc + sc + inc,$$

where

Fc—forage costs, bc—biologic material cost, ec—energy cost, mc—medicines cost, oc—other materials costs, sc—supply cost, and inc—insurance cost

$$MVC\% = MVC/VP \times 100$$

where

MVC—margin on variable costs and VP—value of production

$$BeV = FC \text{ per head}/MVC\% \times 100,$$

where

BeV—break-even point in value units and FC—fixed costs,

$$MVC\% - MVC/VP \times 100$$

where

MVC—margin on variable costs and VP—value of production

$$BeP = BeV/Pc,$$

where

BeP—break-even point in physical units, BeV—break-even point in value units, and Pc—production cost

$$ORR = BeV/VM \text{ per head} \times 100,$$

where

ORR—operating risk rate, BeV—break-even point in value units, and VM—value of main production

$$SI = (VM \text{ per head} - BeV)/VM \text{ per head, in which SI–security index},$$

where

VM—value of main production and BeV—break-even point in value units.

3. Results

3.1. Young Sheep for Fattening Farm

In the fodder ration for young fattening sheep, sorghum silage replaces half of the amount of maize silage (as a crop affected by drought), the amounts being 1.5 kg of each, along with 0.4 kg of alfalfa hay and 0.1 kg of concentrates such as corn and barley grain and sunflower meal; these quantities cover the feed norms recommended by animal nutrition specialists (Table 1).

Table 1. Sorghum silage ratio/head.

Forages	kg/Head/Day	UNC	PDI (g)	Quantity/Head/Period	Price, RON/kg	Value/Head/Period
Sorghum silage	1.50	0.41	17.10	210	0.30	63
Maize silage	1.50	0.3	19.5	210	0.15	32
Alfalfa hay	0.40	0.20	30.00	56	0.9	50
Corn grains	0.10	0.14	7.30	14	1.08	15
Barley grains	0.10	0.12	6.5	14	1.09	15
Sunflower meal	0.10	0.07	22.6	14	1.17	16
Total		1.23	103.00			191.7
Norm		1.23	100.00			

UNC—nutritive unit meat; PDI—digestible protein; RON—Romanian national currency. Source: Authors' own elaboration.

The ration structure includes 40% each corn silage and sorghum silage, 11% alfalfa hay, and 3% each corn, barley, and sunflower meal (Figure 1).

In the meat production activity on the farm, several limiting production factors are involved (land, forages, biological material, labor force, etc.); therefore, the economic evaluation must take place in relation to the resources used [31].

In the budget of income and expenditures, feed and biological material occupy approximately equal shares within the variable expenses, which represent 86.3% (429,639 RON) of the total expenses (640,000 RON). The other cost elements are energy, medicine, other material costs, supplies, and insurance. Within fixed expenses, labor costs have the largest share, representing 59%, the rest being general costs, interest, and depreciation (Table 2).

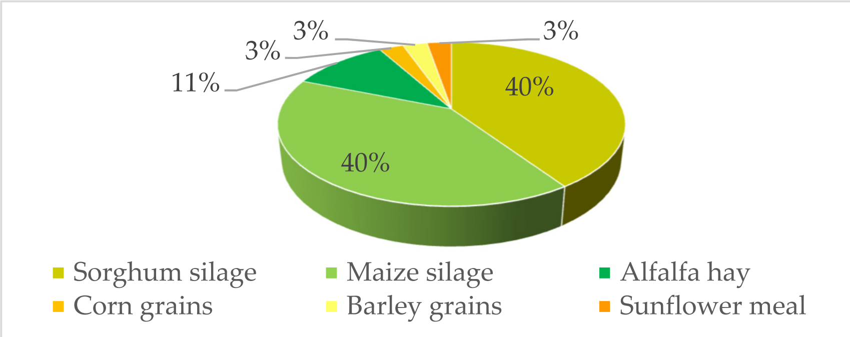

Figure 1. The structure of the fodder ration.

Table 2. Budget of income and expenditures on farm.

Indicators	Average Daily Gain 200 g, Life Weight at Sale 40 kg/Head		
	RON/Head	**RON/kg**	**Value/Farm**
Value of production	640.0	16.00	640,000
Value of main production	640.0	16.00	640,000
Subsidies	0.0	0.00	0.00
Gross product	640.0	16.00	640,000
Total costs	497.7	12.44	497,656
Costs for main production	497.7	12.44	497,656
Variable costs	429.6	10.74	429,639
Forage costs	191.7	4.79	191,660
Biologic material cost	195.6	4.89	195,600
Energy cost	10.0	0.25	10,000
Medicines	14.0	0.35	14,000
Other material costs	6.0	0.15	6000
Supply	10.0	0.25	10,032
Insurance cost	2.3	0.06	2347
Fixed costs	68.0	1.70	68,017
Labor cost	40.0	1.00	40,000
General expenses	10.4	0.26	10,432
Interest rates	12.6	0.31	12,586
Amortization costs	5.0	0.13	5000
Taxable income	142.3	3.56	142,344
Taxes and fees	14.2	0.36	14,234
Net income + subsidies	128.1	3.20	128,109
Rate of return%	28.6	28.6	29
Net income rate%	25.7	25.7	26
Production cost	497.7	12.44	497,656
Price	640.0	16.00	640,000

Source: Authors' own elaboration.

The calculations indicated that the activity of the young sheep for the fattening farm is a profitable activity, with the production cost (12.44 RON/kg) being lower than the average prices (16.00 RON/kg) recorded on the free market, so the profitability rate is 28.6%.

3.2. Young Cattle for Fattening Farm

For the cattle for the fattening farm, summer and winter rations were calculated, using millet as fodder adapted to drought conditions, in summer completely replacing the green fodder, and in winter as silage (Table 3).

Table 3. Green millet summer ratio/head.

Forages	kg/Head/Day	UNC	PDI (g)	Quantity/Head/Period	Price, RON/kg	Value/Head/Period
Alfalfa hay	0.50	0.25	37.50	91	0.90	82
Green millet	5.00	1.15	97.00	910	0.18	164
Sunflower meal	0.48	0.34	108.48	87	1.17	102
Barley grains	4.90	5.88	318.50	892	1.09	972
Total		7.62	561.48			1320
Norm		*7.60*	*562.00*			

UNC—nutritive unit meat; PDI—digestible protein; RON—Romanian national currency. Source: Authors' own elaboration.

In the summer ration structure, 46% is green millet, 45% is barley, 5% is alfalfa hay, and 4% is sunflower meal (Figure 2).

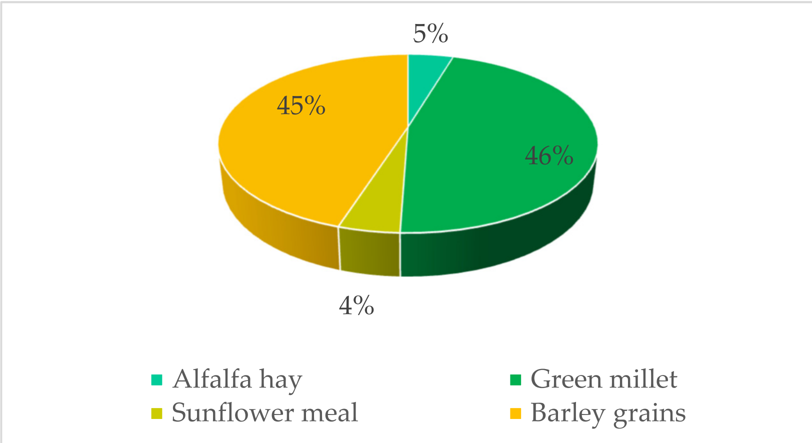

Figure 2. The summer ration structure.

The rations are supplemented with alfalfa hay in both seasons, as well as concentrated fodder, such as corn, barley, and sunflower meal (Table 4).

Table 4. Millet silage winter ratio/head.

Forages	kg/Head/Day	UNC	PDI (g)	Quantity/Head/Period	Price, RON/kg	Value/Head/Period
Alfalfa hay	1.20	0.59	90.00	220	0.90	198
Millet silage	5.00	1.25	86.65	915	0.40	366
Sunflower meal	0.41	0.29	92.66	75	1.17	88
Corn grains	4.00	5.48	292.00	732	1.08	791
Total		7.61	561.31			1442
Norm		*7.60*	*562.00*			

UNC—nutritive unit meat; PDI—digestible protein; RON—Romanian national currency. Source: Authors' own elaboration.

The structure of the winter ration includes 47% millet silage, 38% corn grains, 11% alfalfa hay, and 4% sunflower meal (Figure 3).

Within the income and expenditures budget, variable costs represent 83%, the rest being fixed costs. The cost of forages occupies 66.5% of the variable expenses, constituting the main input. Per kg of live weight, the cost of feed is 6.14 RON. Total cost per kg is 10.52 RON, and the delivery market price is, on average, 11.45 RON, which leads to a rate of return of 8.9%. The rate of net income with subsidies increases to 14.4% (Table 5).

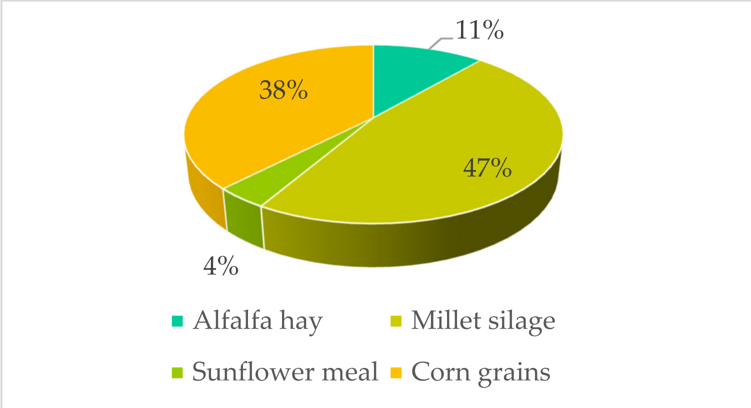

Figure 3. The winter ration structure.

Table 5. Budget of income and expenditures on farm.

Indicators	Average Daily Gain 1000 g, Life Weight at Sale 450 kg/Head		
	RON/Head	RON/kg	Value/Farm
Value of production	5422.5	12.05	542,250
Value of main production	5152.5	11.45	515,250
Subsidies	303.4	0.67	30,340
Gross product	5725.9	12.72	572,590
Total costs	5003.6	11.12	500,357
Costs for main production	4733.6	10.52	473,357
Variable costs	4151.9	9.23	415,191
Forages	2762.0	6.14	276,196
Biologic material	1200.0	2.67	120,000
Energy cost	30.0	0.07	3000
Medicines	75.0	0.17	7500
Other material costs	10.0	0.02	1000
Supply	60.6	0.13	6055
Insurance cost	14.4	0.03	1440
Fixed costs	851.7	1.89	85,165
Labor cost	715.2	1.59	71,520
General expenses	61.2	0.14	6115
Interest rates	42.0	0.09	4200
Amortization costs	33.3	0.07	3330
Taxable income	418.9	0.93	41,893
Taxes and fees	41.9	0.09	4189
Net income + subsidies	680.4	1.51	68,044
Rate of return%	8.9	8.9	8.9
Net income rate%	14.4	14.4	14.4
Production cost	4733.6	10.52	473,357
Price	5152.5	11.45	515,250

Source: Authors' own elaboration.

Comparing the economic and risk indicators of the activity in the two ruminant farms, it is found that the production value per kg of live weight is higher in sheep than in cattle by 32.7% (16 RON compared to 12 RON), but, at the same time, the production cost is higher in sheep compared to cattle, by 18.3%. The margin on variable costs is 87% higher in sheep than in cattle. Break-even point in physical units is reached for sheep at 12.93 kg/head and for cattle at 317.43 kg/head (Table 6).

As illustrated in Figure 4, the value for main production is 39.7% higher in the sheep farm than in the cattle one.

In Figure 5, different categories of expenses per kg of live weight from the two farms are comparatively highlighted, and it can be seen that, apart from fixed expenses, respectively, those with labor force, the other categories of unit costs are lower for cattle than in sheep farms. This could be explained by the differences regarding the period of exploitation of the two species, the animals weight at delivery, as well as the specific allocations of inputs (Figure 5).

Table 6. Comparison between farm economic and risk indicators.

Indicators	Measure Unit	Sheep	Cattle	Sheep/Cattle
Value of total production	RON/kg	16.00	12.05	1.33
Value of main production	RON/kg	16.00	11.45	1.40
Total costs	RON/kg	12.44	11.12	1.12
Costs for main production	RON/kg	12.44	10.52	1.18
Variable costs	RON/kg	10.74	9.23	1.16
Material costs	RON/kg	10.18	8.99	1.13
Fixed costs	RON/kg	1.70	1.89	0.90
Labor cost	RON/kg	1.00	1.59	0.63
Production cost	RON/kg	12.44	10.52	1.18
Unitary price	RON/kg	16.00	11.45	1.40
Profit/kg	RON	3.56	0.93	3.83
Rate of return	%	28.60	8.85	3.23
Margin on variable costs	RON	5.26	2.82	1.87
Margin on variable costs %	%	32.87	23.43	1.40
Break-even point in value units	RON	206.94	3634.62	
Break-even point in physical units	kg/head	12.93	317.43	
Operating risk rate	%	32.33	70.54	0.46
Security index		0.68	0.29	2.34

RON—Romanian national currency. Source: Authors' own elaboration.

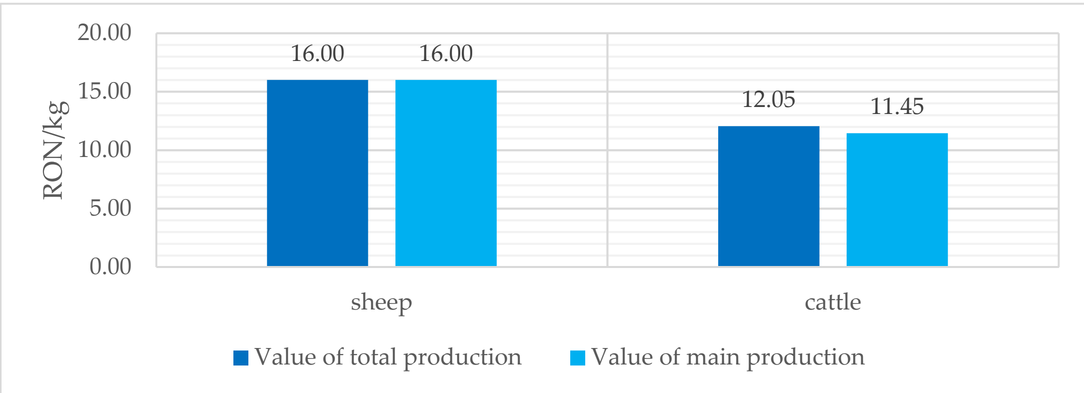

Figure 4. Farms comparative unitary values of production.

From the perspective of economic sustainability, the calculations indicated that in both activities, the costs are covered by the revenues obtained and are profit-producing, which ensures the resumption of production cycles, as the issue of financial stability is a component of economic sustainability [32]. In the case of the sheep farm, the profit is higher than that of cattle (8.85% for cattle and 28.6% for sheep), and this is also due to the higher delivery price (Figure 6). The two categories have different delivery channels in Romania, as well as different consumer preferences. Young, fattened sheep are valued much better on foreign markets, especially the Arab ones, and young bull meat, although more often delivered internally, is still not at the top of consumers' preferences, but poultry and pork.

Any economic activity is accompanied by a certain level of risk, due to a complex of factors taking place and which can influence it, and the calculation of the risk indicators in this case (operating risk rate and security index) indicates a higher risk in the case of the cattle farm, the indicator being the result of the ratio between the break-even point in value units and the value of the main production, which is more advantageous in the case of the sheep farm.

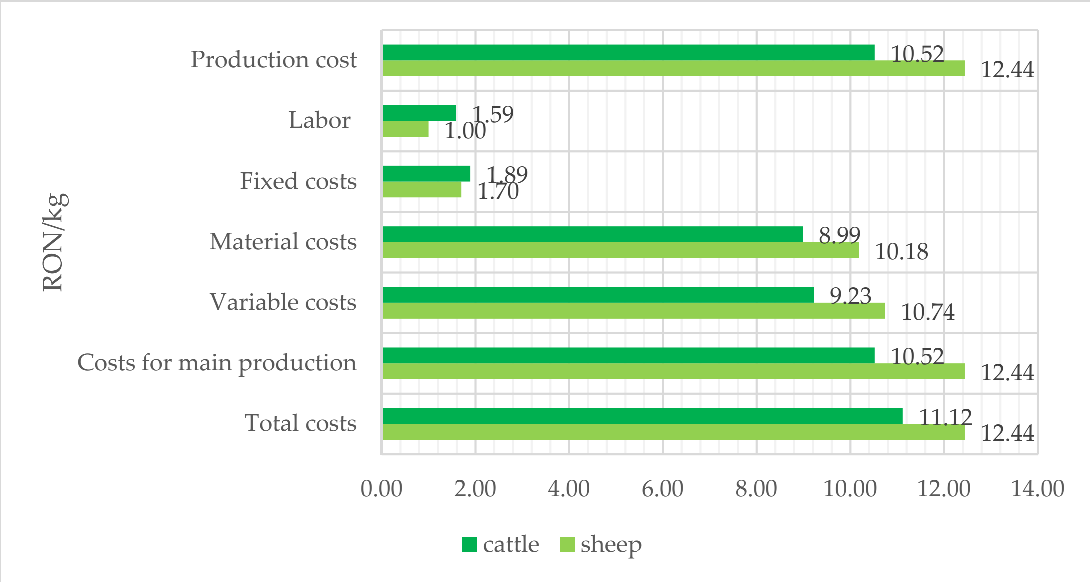

Figure 5. Farms comparative unitary expenditures.

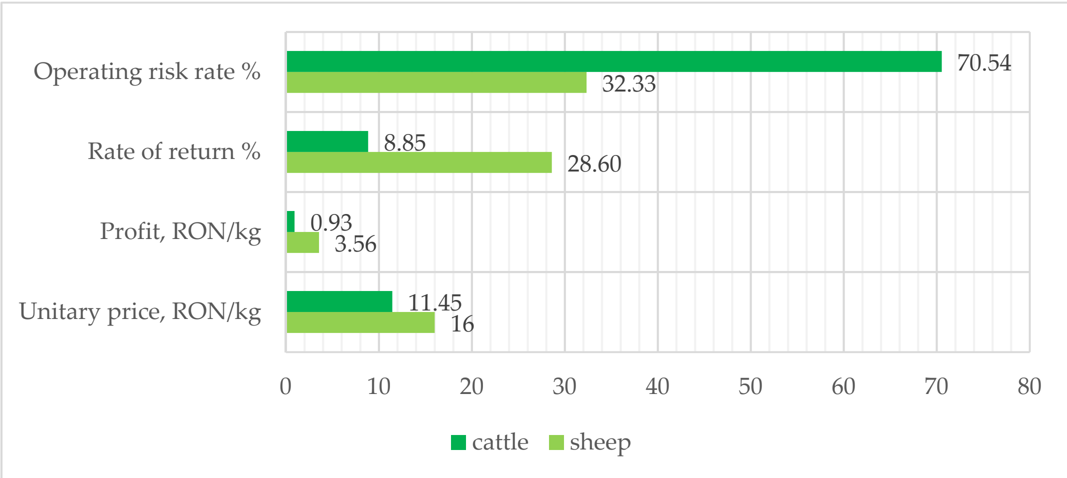

Figure 6. Farms comparative profitability and risk values.

4. Discussion

In sustainable systems, limited natural resources are used over time and subject to conditions of uncertainty [32]. Economic sustainability is a key concern for most farmers, given that it can influence the business continuity decision. Many variables have been found to be significant in ensuring farm profitability, including farm management, quality and availability of agricultural resources, financial management, finding alternatives in conditions of economic vulnerability, etc. [33,34]. The profit ratio is used to compare profitability between farms, and in this case, the value being higher for the sheep farm than the cattle farm is due both to the technological specificities, the consumption of different inputs, the different duration of the productive cycle, which is higher for cattle compared to sheep, as well as and due to the level of sale prices for animals; for sheep, they are higher [34].

The paper presents scenarios regarding the use of alternative fodder in the new environmental and climate conditions, highlighting the obtaining of profit, which can represent a measure that ensures economic sustainability, by calculating the technical–economic indicators that farmers can approach.

Increasing farm production, by this understanding the level of average production, has a significant role in increasing profitability for different farm sizes, but it is even more important for small ones, which also have a higher economic risk [35]. Previous research has shown that different expenditure categories are negatively related to revenue and profitability [36].

Due to increasing consumer demand for food safety, direct-to-consumer marketing channels have been promoted to shorten the supply chains and reduce the number of intermediaries, thus reducing the number of manipulations, especially for fresh products. However, previous research shows that the number of farms using direct-to-consumer marketing channels is still low, and although direct marketing is promoted, wholesale markets are the most profitable marketing channels [37]. In Romania, live cattle are generally delivered to slaughterhouses, respectively, meat processing units or as live animals for export (to a lesser extent), and sheep are generally sold live to customers in Arab countries, or some from Western Europe. This means that animals are sold more as raw materials without added value, which affects the level of profitability.

Resilience and efficiency are components of the sustainability of ruminant productions, and therefore, studying and finding solutions regarding the ability of their production systems to survive and adapt to current climate trends and future challenges are of great importance [38]. In general, sheep are raised on pasture in relatively large flocks and have a higher thermal tolerance compared to large ruminants—cattle [39].

Nutritional management represents one of the pillars of the production and sustainability of livestock in terms of intensification productions. Feeding carries the major costs and greatly influences the quality of products obtained and the impact on the environment [40]. Climate change will intensify, and farmers will be affected, as they rely on climate-sensitive livelihoods. Appropriate adaptation strategies for farmers depend on a clear description of the effects of climate change. In the research conducted by Chingala et al. [41], it was found that high-income farmers have the capital to acquire resources to improve pasture productivity, so income level was one of the major economic factors influencing farmers' perceptions of the impact of climate changes on beef production. This indicates the importance of considering socio-economic factors when developing strategies to adapt to climate change and reduce vulnerability for beef producers.

How can feed alternatives contribute to a reduction in meat production decline? Estimates indicate that replacing or supplementing fodder rations with alternative forages in conditions where classic fodder, such as corn, can be affected and reduced quantitatively and qualitatively can contribute to ensuring the nutritional principles necessary to obtain the planned production level and to avoid the decrease in production of meat.

Many livestock production systems consider increasing efficiency and environmental sustainability features. Production trends in different animal husbandry systems have been associated with the development of science and technology as well as the increase in animal numbers. In the future, production is expected to be increasingly influenced by competition for natural resources and food and forages. The demand for animal products in the future will be determined by socio-economic factors, to which climatic factors will be added [42]. Despite the many challenges facing livestock producers, including economic pressure and feed availability, livestock production is projected to continue to support growth in world meat production. Under heat stress, production can be improved by changes in diet composition [43].

The contribution of ruminants to food security and other dimensions of sustainability will be affected by climate change, although the magnitude of the impact remains unknown. Livestock and climate change studies often focus on describing adaptation practices, like the present study. Climate-related impact risks result from the interaction of climate-related hazards with the exposure and vulnerability of natural systems [44,45].

Livestock rearing is a major factor in increasing the overall contribution to household livelihoods, and on the other hand, livestock can provide immediate income that helps cover important household expenses. In general, the demand for meat has increased among the population, which is increasingly urbanized [44].

Beef cattle are raised globally, following different management practices, and those in colder regions are vulnerable to high environmental temperatures. The use of natural resources such as feed in different production systems is different, and finding solutions to prevent their depletion will have to be a constant challenge [46].

By focusing on the use of drought-resistant crops, such as millet and sorghum, this study involved analysis of resource efficiency and resilience in the production system—two very important facets of the bioeconomy. A bioeconomy system minimizes waste, restores resources, and regenerates land. Replacing water-demanding crops, which include maize, with sorghum and millet could contribute to that since it optimizes the use of natural resources, such as water, at equal or higher levels of productivity in fragile climates. Indeed, sorghum has proved that it may afford high water use efficiency—even outcompeting other crops like corn in dry areas—while still offering excellent nutritional value for livestock [47]. Besides that, the sorghum plant succeeds in semi-arid conditions, eventually reducing overdependence on other water-consuming crops, adding to a more sustainable and regenerative agricultural system in a major way [13,14,47].

Millet was also found to be very adaptable to marginal lands with high levels of salinity, waterlogging, and pest infestations [48]. Therefore, it thrives under conditions that would hardly support other cereal crops. The crop's relatively short growing season, usually three to four months, and a resistant nature against most diseases reduce the level of input required for its cultivation, hence positioning millet as more viable where means are limited [47–49]. Another critical reason for its increased importance is the crop's high value as a fodder source for livestock, considering that the crops are rich in protein; this effectively reduces feed costs and contributes to attaining food security through sustainable livestock production [50]. Therefore, millet makes very important contributions to bioeconomy applications beyond being a food crop. When the grains are harvested, the straw becomes valuable forage for animals, hence embracing the no-waste model, which is an important aspect of the bioeconomy approach [51,52]. It is resilient to adverse abiotic environmental stresses like salinity and drought, hence requiring minimal chemical use, consequently reducing environmental pollution while optimizing yield [53]. The contribution to the bioeconomy in this case is through optimized resource use and circularity in resource flow.

Aside from this, ensuring that the economic calculations of fattening farms for sheep and cattle are optimized will enhance profitability and contribute to the circular economy by efficiently using inputs like feed. This, in turn, makes more effective use of the available resources in a very strategic manner—a core principle of the circular economy closing the resource loops. It has been observed that diversification with sustainable crop alternatives like sorghum reduces the application of water and enriches the soil health, hence making sorghum a very feasible crop within the perspective of the circular economy [54].

5. Conclusions

Following the recommendations of animal nutrition specialists to introduce substitute feed, resilient to the new environmental and climate conditions, into the forage ration of ruminants for meat is one of the solutions to adapt to the effects of drought. The use of sorghum and millet, as green fodder in summer rations and as silage in winter rations, to completely or partially replace some drought-sensitive forages, such as green maize, can provide the necessary nutrients to achieve the planned average daily weight gain.

The calculations of the technical–economic and risk indicators of the activity indicated the fact that, both in the case of young sheep for fattening and of cattle, the production activity can be completed with obtaining a certain level of profit. The economic impact is given by the financial results that farms obtain under the action of different factors. In conditions of adaptation to climate change, the rate of return indicator, which had positive values of 8.85% for cattle and 28.6% for sheep, indicated that adaptation measures can have economically valid responses. Results underlined that these crops, included in rations, reduce not only the vulnerability of farming to climate-induced shocks but also contribute to the circular economy through the optimization of resources and minimization of waste. Therefore, the practices of sustainable feeding guarantee the continuity of activities on the farm with increased productivity and at reduced cost.

There are, however, some limitations that have to be considered for further research, including the geographical specificity of the present study, limited crop diversity, and the addition of several more economic parameters that describe market fluctuations. Nevertheless, this study provides a good understanding of how resilient agricultural practices, coupled with circular economy principles of reducing material inputs such as water and energy, are in agreement with promoting economic and environmental sustainability in ruminant meat production. These are the kinds of strategies that, as climate change continues to threaten agricultural systems worldwide, will prove necessary for farm profitability and food security over the coming decades.

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