AIR POLLUTION CONTROL APPLYING OPTIMAL MILK PRODUCTION MANAGEMENT

Vilma Naujokienė[1*], Rolandas Bleizgys[1], Simona Paulikienė[1], Kęstutis Venslauskas[1]

VYTAUTAS MAGNUS UNIVERSITY AGRICULTURE ACADEMY

INTRODUCTION

One of the main sectors in terms of GHG emissions is agriculture, which accounts for 22.9% of total GHG emissions. GHG contains mainly carbon dioxide CO_2, which in Lithuania makes up 65.4% (of which 6% in animal husbandry), methane - 16.8% (of which 8% in animal husbandry), and nitrous oxide - 15.4% (of which 10 % in livestock) of total GHG CO_2 eq. Fluorinated gases: HFCs, SF_6 and NF_3 together accounted for 2.4% of total GHG emissions in Lithuania. Due to agricultural activities, GHG emissions of 4602 kt CO_2 eq. About 45% of the gas (2071 kt CO_2 eq.) Evaporates in livestock farming. The agricultural sector accounts for the largest share of N_2O at 85.1% of total N_2O and CH_4 at 57.2% of total CH_4. GHG emissions from livestock production include: CH_4 from digestive processes - 79% (1655 kt CO_2 eq.), CH_4 from manure management systems - 14% (290 kt CO_2 eq.), N_2O from manure - 7% (126 kt CO_2 eq.) (Lithuania's, 2019). Farmers and society as a whole have been found to benefit from investing in climate-friendly agriculture that reduces greenhouse gas emissions (Branca et al., 2021). Also new expansion methods for a changing climate, such as information and communication technology (ICT) - based extension services and climate information services, have been found to help farmers at grassroots level (Raj et al., 2020). The environmental footprint of Alpine dairy products (milk, cheese, butter) showed that the impact was mainly due to milk production and very little to milk processing (Berton et al., 2021). LCA was used to quantify the effects of the distribution and management of feed components on the carbon footprint of dairy production. The GHG emissions of the systems were found to differ significantly in terms of total and source category emissions, and most management systems found a significant average difference in embedded emissions (March et al., 2021). The main factor influencing the 6 main exposure categories was individual milk production, which showed the importance of livestock intensity, and limited land availability can have a negative impact on environmental performance (Zucali et al., 2020). The group of processes responsible for direct emissions from cattle farming (enteric fermentation and manure management) had the greatest impact on climate change and acidification. . In the case of mixed livestock farming, the reduction of both the overall environmental impact and the cost should be key factors in improving the eco-efficiency of milk production. In the case of mixed livestock farming, the reduction of both the overall environmental impact and the cost should be key factors in improving the eco-efficiency of milk production (Bieńkowski et al., 2021).

METHODS

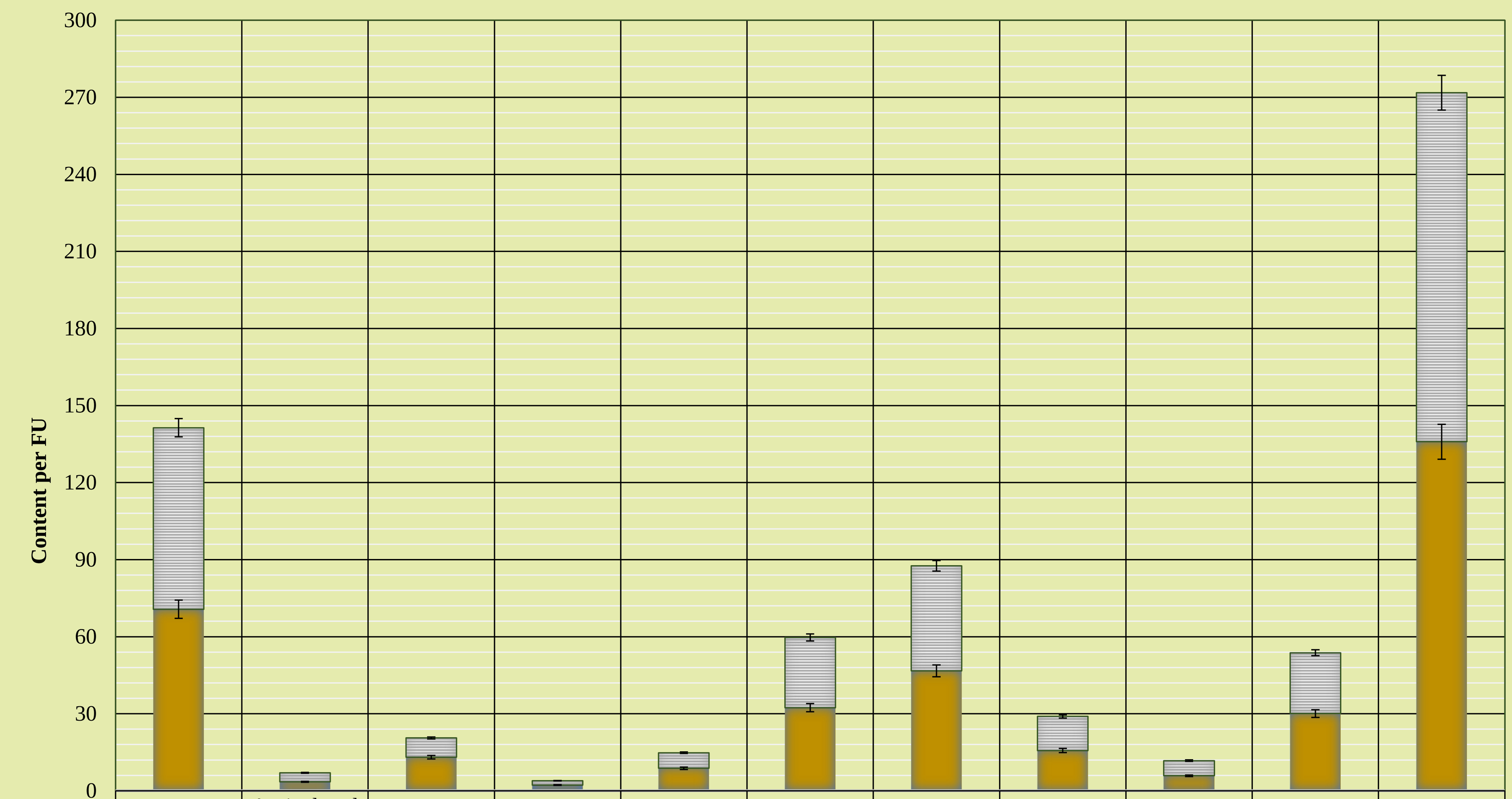
The goal of this study was to evaluate the environmental burdens associated with milk production in Lithuania through a LCA approach. One of milk production sector was identified as the main hotspot in the production chain, biostrategy were proposed as alternatives to mitigate the environmental impacts related to the entire system. The management model includes the following milk production processes:
- fodder production (crop-cereal production, pastures), silage production, fodder preparation and storage, preparation of climate-friendly rations, feeding;
- animal housing (barns), housing systems and methods, automation of technological processes, improvement of housing conditions, herd management systems;
- manure handling: removal from barns, storage, incorporation into the soil.

The environmental impact assessment was conducted by SimaPro 9.1 process modelling software. The data on milk production, biomass cultivation and feed preparation, transportation and equipment were used from Ecoinvent v3 database. Based on CML-I calculation methodology was determined resulting impact of processes. The model of holistic dairy farm is based on assumption, that farm contains 240 milking cows per year. Each cow produces 6225 kg of raw milk with 3XX % fat and 4YY % proteins. Farms keep daily records of the productivity of each cow. The cow is milked 305 days a year and is weaned 60 days before calving. Productive cows are milked on average 4 lactations, 4 years and then sold for meat (not suitable for sausages, steaks). About 60 cows are culled every year, and both cows are sold for meat. They are replaced by young and beautiful.

The average daily water consumption per cow is 100 l (80 l to drink from it). One cow needs 36,500 liters of water a year. The water must be of drinking water quality. Corn silage is produced in a trench grass silage is produced in rolls. The feed mixture is prepared in a stationary trolley and the feed is distributed by a robot. Amount of feed per cow per year: hay 440 kg; grass silage - 5250 kg; corn silage - 5230 kg; green fodder grass - 8990 kg; concentrated feed 1350 kg.

RESULTS

The environmental impact assessment shows that the other environmental categories in LCA also have the highest environmental impact - grass silage, bread silage and concentrate in the feed stock. looking at the critical points in the Clasic SC scenario, the cultivation technology is adjusted to replace 50% of N fertilizers in bioproducts. In the Bio SC scenario, the amount of coal per FU would decrease to 21.3% (23.68 kg FU), natural gas - up to 15.2% (13.29 m^3 FU), lime - up to 12.4% (40.89 kg FU), diesel - up to 15.5 % (27.36 kg FU), calcium nitrate - up to 30.9% (6.06 kg FU), ammonium nitrate - up to 22.5% (1.73 kg FU), ammonia - up to 42.7% (7.49 kg FU) and agricultural machinery - up to 0.6% (3.50 kg FU) (Fig.1).



	Hay, kg	Agricultural machinery, kg	Ammonia, kg	Ammonium nitrate, kg	Calcium nitrate, kg	Diesel, kg	Lime, kg	Natural gas, m	Water, m	Coal, kg	Electricity, MJ
Bio SC	70,68	3,50	7,49	1,73	6,06	27,36	40,89	13,29	5,86	23,68	135,90
Clasic SC	70,68	3,52	13,07	2,23	8,76	32,36	46,68	15,67	5,86	30,07	135,90

Milk production stocks

Figure 1. Data on basic stocks of milk production per FU

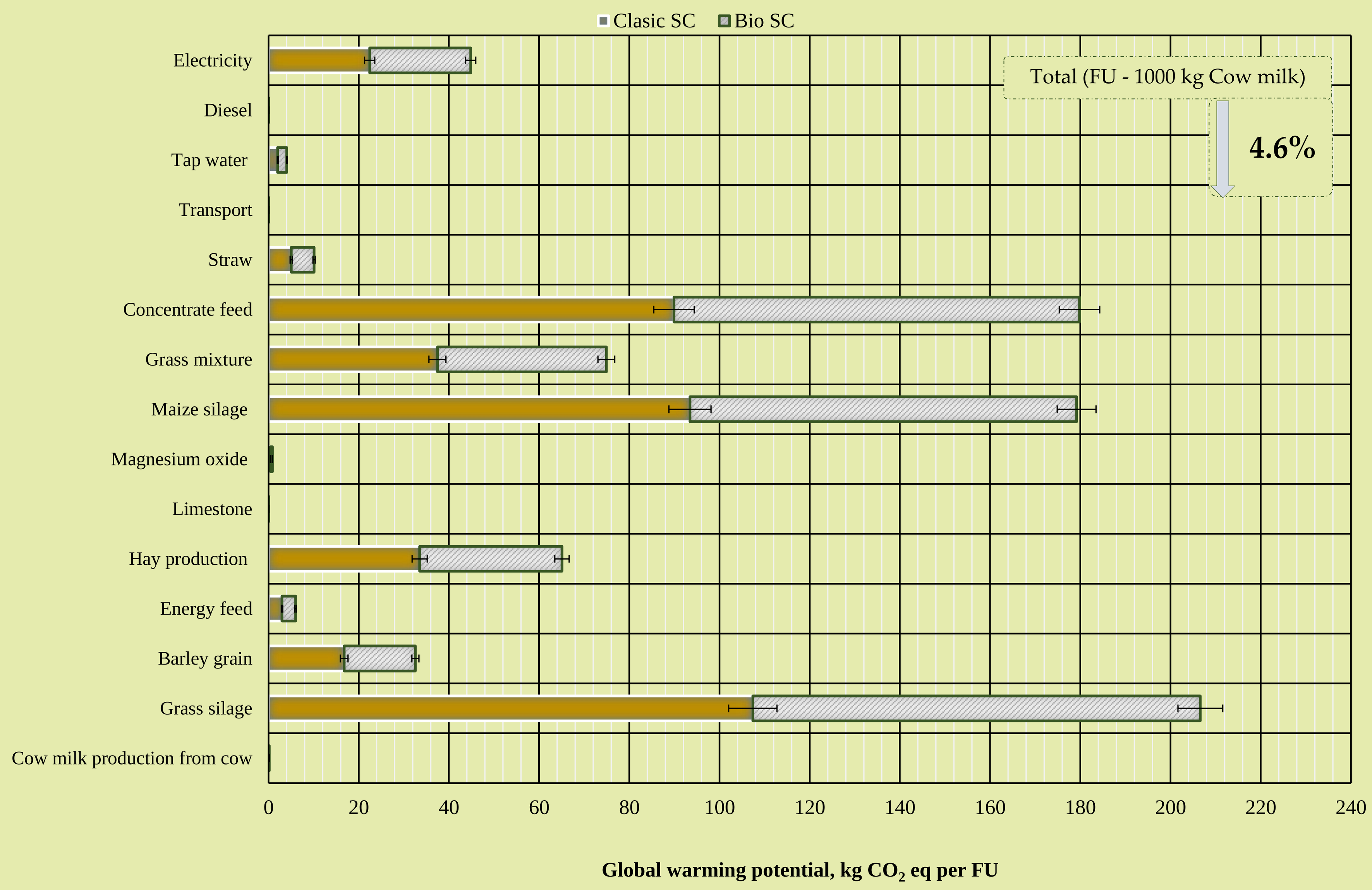


Figure 2. Global warming potential of milk production stocks per FU

The data show that the largest share of CO_2 emissions determined in the stock is grass silage (Clasic SC - 107.4 kg CO_2 eq FU), which accounts for 26.09% of the total CO_2 emissions from milk production stocks. Also, the use of biopreparations reduces the global warming potential of milk production stocks per FU and in barley grain, hay production and bread silage stocks, respectively, to 5.9% (Clasic SC - 16.79 kg CO_2 eq FU/ Bio SC - 15.79 kg CO_2 eq FU), 5.9% (Clasic SC - 33.52 kg CO_2 eq FU / Bio SC - 31.55 kg CO_2 eq FU) and 8.2% (Clasic SC - 93.45 kg CO_2 eq FU / Bio SC - 85.75 kg CO_2 eq FU). The total global warming potential of milk production stocks per FU would decrease to 4.6% (Bio SC - 392.75 kg CO_2 eq FU) (Fig. 2).

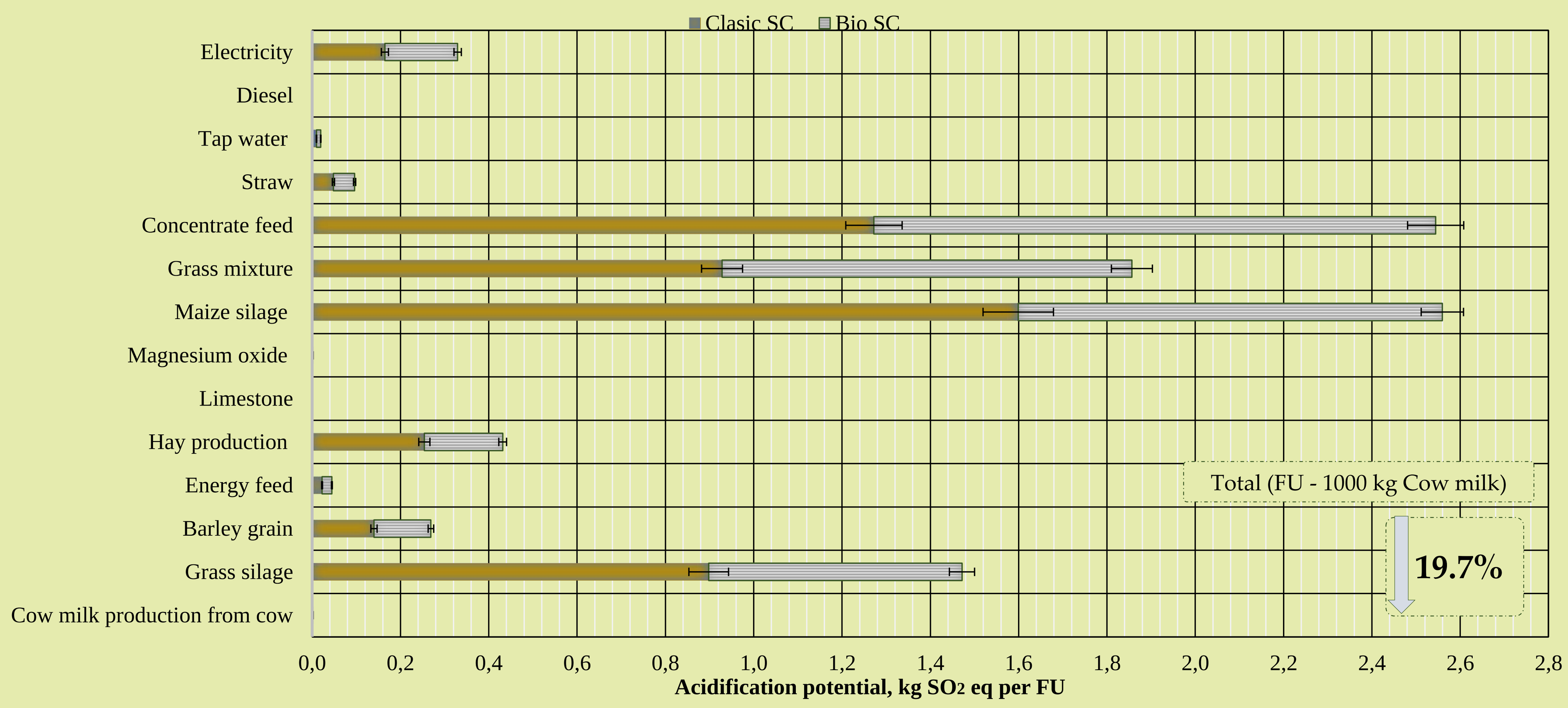


Figure 3 Acidification potential of milk production stocks per FU

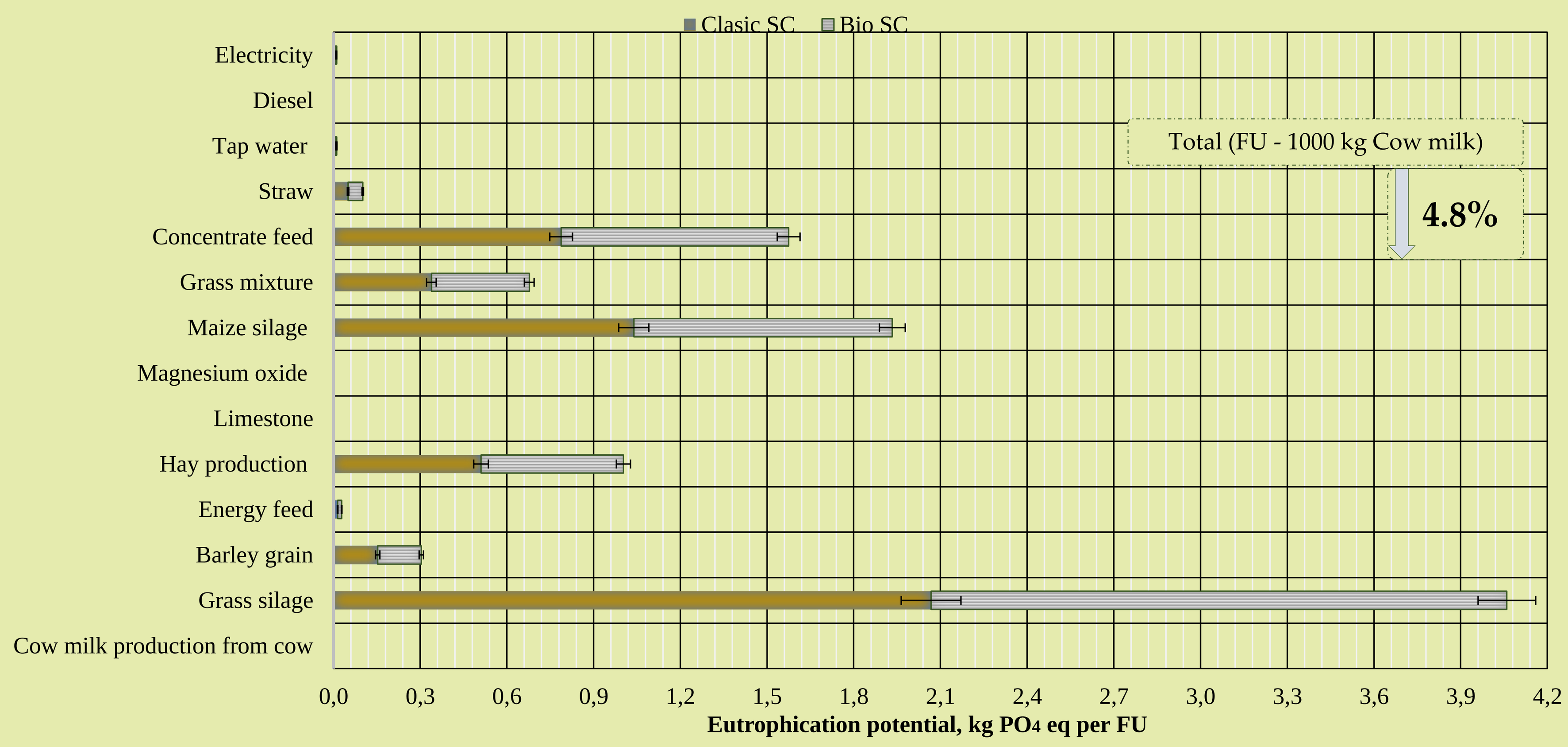


Figure 4. Eutrophication potential of milk production stocks per FU

The highest sulfur dioxide emission potential was recorded in the Clasic SC bread silage stock (1.60 kg SO_2 eq FU), which accounts for 29.96% of total SO_2 emissions from open sources. When converting fertilizers to biopreparations, the sulfur dioxide emission potential in this part is reduced to 39.9% (Bio CS - 0.96 kg SO_2 eq FU). The use of biopreparations would reduce the total acidification potential of milk production stocks per FU to 19.7% (Bio SC - 4.29 kg SO_2 eq FU). In the part of the milk production process of the Clasic SC bread silage scenario, the amount of PO_4 emissions is - 20.89% (Clasic SC - 1,039 kg PO_4 FU) of the total production of PO_4 compounds, hay production - 15.84% (Clasic SC - 0.511 kg PO_4 FU) and barley grain - 3.07% (Clasic SC - 0.153 kg PO_4 FU). The use of biopreparations in the categories reduces the environmental impact from 0.1% to 45.7% in the stocks of milk production technology grass silage, barley grain, hay production and maize silage.

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CONCLUSIONS

- Grass silage, bread silage and concentrate feed were established to account for the largest share of gas emissions, accounting for 26.09% (107.39 kg CO_2 eq FU-1), 22.70% (93.44 kg CO_2 eq FU-1) and 21.85%, respectively.
- Climate smart technology is adjusted with climate smart holistic managment and critical points are set, where 50% of N fertilizers are converted to bio-products. The evaluation of the changed technology showed that in the bio SC scenario the amount of coal per FU would decrease to 21.3% (23.68 kg FU-1), natural gas - up to 15.2% (13.29 m^3 FU-1), lime - up to 12.4% (40.89 kg FU-1).), diesel - up to 15.5% (27.36 kg FU-1), calcium nitrate - up to 30.9% (6.06 kg FU-1), ammonium nitrate - up to 22.5% (1.73 kg FU-1), ammonia - up to 42.7% (7.49 kg FU-1) and agricultural machinery - up to 0.6% (3.50 kg FU-1).
- The use of bioproducts reduces the environmental impact from 0.1% to 45.7% in the stockpiles of milk silage, barley grain, hay production and maize silage.
- Climate smart holistic management system reduces environmental impact from 4.6% to 19.7% in all exposure categories. It mainly affects crops grown for animal feed.

Vytautas Magnus University, Lithuania

* Corresponding author: vilma.naujokiene@vdu.lt