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LIFE CYCLE ASSESSMENT AND POTENTIAL OF CAMELINA MEAL FOR DAIRY CATTLE NUTRITION IN ROMANIAN COMMERCIAL FARMS

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Abstract

In Romania, up to 90% of the farms have linked the agricultural and animal husbandry business in order to reduce the inputs and to increase profitability and business sustainability. Camelina sativa is also an rotational oil seed crop, harvested and used after oil extraction as a protein meal in romanian dairy commercial farms
This study shows the nutritional potential of Camelina sativa meal, by-product from Camelina seeds after oil extraction, oil used as renewable source for several types biofuels.
Feeding is the biggest input in dairy cattle farms, due to higher worldwide demand, protein is one of biggest financial inputs in dairy cattle nutrition of commercial farms. Moreover, traditional protein meals are not available for whole seasons and solutions are sought permanently.
In order to reduce the inclusion rate of traditional meals such as soybean meal, rapeseed meal and sunflower meal, any source of protein is welcomed, especially when is a by-product from renewable biofuels production that enters in the food production chain.
We performed a study for assessing the inclusion rate of traditional meals in several commercial dairy farms with more than 300 milking cows, were the consumption of protein meals are important due to high milk production.
Camelina meal has big potential to replace up to 15% of the protein concentrate which will provide a better utilisation of biofuels technology by-products, from financial point of view and more important, there might be an environmental protection due to reduction of Greenhouse gases resulted from biofuels whole chain production, determined with Life Cycle Assessment method.

Key words: *camelina meal, dairy cows, life cycle assessment.*

INTRODUCTION

Nowadays, globally the trend in commercial dairy farms is to produce more milk in order to cover demand for milk and dairy products consumption generated by developing countries (OECD-FAO, 2010). This trend also applies to Romania, due to increased milk production of commercial dairy herds, farmers will need to expand the surfaces cultivated for forages, energy and protein feeds, for correlation of the feed and forages consumption with increased milk production. This will generate an land use change in favour of green forages surfaces but the demand for cereals will remain the same. In this situation any by-product from industries with nutritional value for ruminants can be a good solution for keeping the balance of land use change.
Any increasing of feed and forages consumption needs to be close followed by environmental considerations. Dairy production systems are main sources of greenhouse gas (GHG) emissions from animal husbandry business, most important in this days is methane (CH4).
According to a global Life Cycle Assessment (LCA) of the cattle dairy sector performed in 2007, the sector emitted around 2000 million tonnes CO2-eq, of which more than 70% were attributed to milk production. The contribution of the global milk production, processing and transportation to total anthropogenic emissions was estimated around 3 percent (FAO, 2010) of the total anthropogenic GHG emissions reported (IPCC 2007).
Methane emissions are by far the largest contributor, accounting for more than 50 percent of the total emissions of this sector, followed with a lower contribution by nitrous

oxide and then carbon dioxide (S. Gerosa and J. Skoet 2012).

Globally, emissions per unit of milk product are estimated at 2.4 kg CO2-equivalent per kg of fat and protein-corrected milk (FPCM) at the farm gate (FAO, 2010). However, values can have big differences among different regions of the world, due to different climate and continuing with different feeding and management systems.

Transportation of protein sources from all over the world to farms also contributes to GHG emissions. If the direct emissions from milk productions cannot be avoided, all other factors such as transportation and preparation of feeds can be reduced if more of the feeds are produced locally or at least regionally.

Main reason than stimulates this development is ability to increase profitability by increasing feed efficiency and productivity of the herds, adopting the many technological innovations which often require high capital and therefore bigger herds to be profitable. At the same time, genetic haves several improvements and also feeding has seen a tendency to shift the ratio between roughages and feed concentrates in order to reach higher yields. However, when it comes to industrialization, milk production is lagging production systems for poultry and pigs, partly because dairy cows normally are fed more bulky and fresh fodder and because of the relative labor intensity of dairy production, which makes economies of scale more difficult to achieve when higher yields and better feed efficiency is a moving target.

Today, there are still major differences between developed and developing countries, where most milk in developing countries still are produced in traditional small scale system minimum mechanization and no feeding and management innovations, although large-scale units can be found also in developing countries (S. Gerosa and J. Skoet 2012).

Most developed countries have seen increasing herd size and higher annual milk production per cow by increasing feed efficiency of energy and protein sources.

This reflects different production systems, correlated with the nutrition of the cows and also to different genetic potential of the animals. The feeding strategy has a major impact on the production obtained. The system in Romania is based on in barn feeding with medium energy-protein rich total mixed rations.

A good opportunity for Romanian farmers who are combining agricultural with animal husbandry businesses can be cultivation of *Camelina sativa* meal as oilseed rotational crop and moreover, the use of Camelina meal after oil extraction as a feed for ruminants.

Camelina is primarily an energy crop, with high oil content for industrial use, as a feedstock to produce renewable fuels, mainly for kerosene used in aviation.

The *by-product* obtained from the oil extraction (camelina cake/meal) has the opportunity to be succesfully used as high protein animal source feed.

Camelina is suitable to be used as an oilseed *rotational crop* with wheat and more important, it has a good potential for cultivation on marginal, uncultivated and contaminated land.

Camelina, though cultivated for over 2,000 years in the area for its seeds containing 30-45% oil, it was used as adjuvant food, in the dye industry, in the soap industry, and more recently, for bio fuel. However, it is little known at present in Romania, though soil and climate conditions are favourable for this crop. Camelina yield potential and optimum cultivation technology was already studied (Moraru A. et al., 2013).

The production was influenced by the sowing date and the climatic conditions of the soils. Nutritional value of Camelina meal (Hurtaud and Peyraud, 2007).

Table 1. Camelina meal nutritional value for ruminants

Nutrional properties	Value
DM %	91,3
CP, g/Kg DM	411
NDF, g/Kg DM	269
ADF, g/Kg DM	144
Fat, g/Kg DM	139
PDIN, g/Kg DM*	257
PDIE, g/Kg DM**	125
NEL, Mcal/kg of DM	2,02

*PDIN = protein digested in the small intestine supplied by rumen-undegraded dietary protein and by microbial protein from rumen-degraded organic matter (INRA, 1989).
**PDIE = protein digested in the small intestine supplied by rumen-undegraded dietary protein and by microbial protein from rumen-fermented organic matter (INRA, 1989).

The inclusion rate of the Camelina meal as a protein source in ratio can be up to 5% of the total ratio, on dry matter basis (Chedea et all., 2014). However, more trials with several cultivars are needed in order to evaluate the increasing of the inclusion rate at a maximum level, according with nutritional safety requirements.

One trial performed in Finland, using red clover silage-based diets and supplemented with Camelina meal at 20% of the concentrate, had no negative effect on silage feed intake, milk yield, or milk composition, but did had a small impact on changing the milk fatty acid composition of the milk (Halmemies-Beauchet-Filleau et all, 2011).

MATERIALS AND METHODS

In this study, we evaluated the usage and the types of protein sources used in one of the biggest commercial dairy farms from Romania and nutritionally potential of Camelina meal to be included in cows daily ratio.

The period of data gathering and farm visit is described in table below.

Table 2. Protein sources and daily feeding quantities

Date	Farm	County	Herd size[1]	Protein sources (meal/cake)	EDF[2]
Dec. 2014	Farm 1	IL	>500	Soybean, Rapeseed, Sunflower, Corn DDGS	1,0
Dec. 2014	Farm 2	GR	<500	Soybean, rapeseed	0,7
Dec. 2014	Farm 3	GR	<500	Soybean, rapeseed	0,6
Dec. 2014	Farm 4	DJ	<500	Rapeseed, sunflower	0,8
Dec. 2014	Farm 5	VN	<500	Rapeseed, sunflower	0,7
Dec. 2014	Farm 6	PH	<500	Rapeseed, sunflower	0,8
Dec. 2014	Farm 7	AB	<2000	Rapeseed, sunflower	1,0
Dec. 2014	Farm 6	IL	<500	Rapeseed, sunflower	0,7
Dec. 2014	Farm 9	PH	<1000	Rapeseed, sunflower	0,9
Feb. 2014	Farm 10	AR	>1000	Soia, DDGS	1,0
Feb. 2014	Farm 11	AR	<300	Rapeseed, sunflower	1,0
Feb. 2014	Farm 12	TM	<1000	Soybean	0,50
Feb. 2014	Farm 13	SV	<100	Soybean	1,0
Feb. 2014	Farm 14	BT	<100	Sunflower	0,5
Feb. 2014	Farm 15	IS	<500	Soybean	1,50
Feb. 2014	Farm 16	IS	<500	Soybean	1,0
Feb. 2014	Farm 17	VS	<500	Soybean	0,50

[1] Herd size is reffered to milking cows only.
[2] EDF=Estimated daily consumption expressed in Kg/cow/day, according with milk yield and currently protein sources.

RESULTS AND DISCUSSIONS

Camelina meal has an good opportunity to be used as a protein source for ruminants in Romania due to a particular dairy farms market, where commercial compound feed is not used by big dairy farms, in order to obtain a better price of making the energy-protein feed in directly in farm.

Nutritional profile is favourable for using it at an inclusion rate of at least 10% of the total dry matter intake of the cow.

Inclusion rate in daily ratio of dairy cows can safely replace up to 20% of protein sources in cow's ratio, as an alternative to seasonal prices of the protein sources.

CONCLUSIONS

The utilisation of this by-product as a protein source in dairy farms can only improve Life Cycle Assessment for *Camelina sativa*, by increasing the value of this crop, starting from agricultural phase, oil extraction, and protein meal utilisation in animal feed, all with less impact for the environment.

All farms will increase milk yield and generate bigger inputs for energy and protein sources. This demand will have an negative impact over the GHG emissions and we must limit this effect by using local and regional by-products in total mixed rations. By utilisation of the local and regional by-products after oil extraction, the economically and environmental impact of cultivation of Camelina will be maximized. All advantages from environmental point of view will be evaluated by applying Life Cycle Assessment method.

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REFERENCES

A. Halmemies-Beauchet-Filleau, T. Kokkonen, A.-M. Lampi, V. Toivonen, K.J. Shingfield, A. Vanhatalo, Effect of plant oils and camelina expeller on milk fatty acid composition in lactating cows fed diets based on red clover silage, Journal of Dairy Science, Volume 94, Issue 9, September 2011, Pages 4413–4430

Bulletin of the International Dairy Federation 445/2010. A common carbon footprint approach for dairy. The IDF guide to standard lifecycle assessment methodology for dairy sector.

Chedea V., Pelmus R., Toma S., Taranu I., Grosu H., & Dragomir C. "Evaluation of Camelina Meal as a Dietary Source of Polyphenol for Dairy Cows." Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Animal Science and Biotechnologies [Online], 71.2 (2014): 279-280. Web. 7 May. 2015

FAO, 2010. Greenhouse gas emissions from the dairy sector: A life cycle assessment. Rome 2009.

Hurtaud C. and J. L. Peyraud, Effects of Feeding Camelina (Seeds or Meal) on Milk Fatty Acid Composition and Butter Spreadability, Journal of Dairy Science, Volume 90, Issue 11, November 2007, Pages 5134–5145.

IPCC, 2007. Climate change 2007: IPCC Fourth Assessment Report. Cambridge University Press, UK.

Moraru A., Jurcoane S., Dimitriu D. 2013, Camelina cultivation for biofuels production. Scientific Bulletin. Series F. Biotechnologies, Vol. XVII, ISSN 2285-1364, pages 24-28.

OECD-FAO, 2010. OECD-FAO Agricultural Outlook: 2010-2019, http://www.agri-autlook.org/45599621.pdf

S. Gerosa and J. Skoet, Milk availability, Trends in production and demand and medium-term outlook, Agricultural Development Economics Division Food and Agriculture Organization of the United Nations, ESA Working paper No. 12-01 February 2012, www.fao.org/economic/esa