DOI: 10.2478/v10014-010-0006-0

COBISS: 1.01
Agris category code: Q01, T01

ENVIRONMENTAL IMPACT EVALUATION OF INNOVATION IN TRADITIONAL FOOD PRODUCTION LINES. PART II: CASE STUDIES

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Received November 10, 2009; accepted February 03, 2010
Delo je prispelo 10. novembra 2009, sprejeto 03. februarja 2010

Environmental impact evaluation of innovation in traditional food production lines. Part II: case studies

Case studies of environmental impact assessment were performed for production steps of three traditional food production lines (dairy cow breeding, dry-cured ham, *Brassica* sp. growing) in order to examine the previously constructed methodological framework. The emission inventory was obtained on the basis of initial experimental data. The emissions were aggregated accordingly for the characterization to environmental impact categories. The contribution of studied process steps to several environmental impact categories was assessed (greenhouse gas emission, acidification potential, eutrophication potential, use of resources and use of agricultural land).

Key words: food industry / traditional food products / cheese / dry-cured ham / *Brassica* / environmental impact / environmental protection / Europe

Ocenjevanje okoljskih vplivov inovacij v proizvodnji tradicionalnih živil. 2. del: primeri študij

V tem prispevku predstavljamo končne rezultate ocenjevanja vplivov konkretnih primerov iz proizvodnih linij tradicionalnih živil na okolje. Na primerih uvajanja inovacij v proizvodnje linije v proizvodnji tradicionalnih živil (sir, pršut, cvetača) smo preverili ustreznost vnaprej vzpostavljenega metodološkega ogrodja za ocenjevanje vplivov na okolje. Na podlagi eksperimentalnih podatkov smo opravili popis emisij, iz popisa pa smo izračunali doprinos proizvodnih postopkov k posameznim kategorijam okoljskih vplivov. Glede na dostopnost in kakovost podatkov smo ocenili doprinos različnih postopkov pridelave k več kategorijam obremenjevanja okolja (izpusti toplogrednih plinov, prekurzorji kislega dežja, prekomerno kopičenje hranil v okolju, potencial za nastajanje ozonskih lukenj, raba kmetijskih površin in raba drugih virov).

Ključne besede: živilska industrija / tradicionalna živila / sir / pršut / cvetača / *Brassica* / vplivi na okolje / varstvo okolja / Evropa

1 INTRODUCTION

The notions of innovation and tradition are commonly perceived as counterparts. However, this discrepancy fades, when the historical point of view of innovation is considered. Many traditional products, especially traditional food products, were bearing signs of innovation at the time of their initial introduction.

It has been shown that consumers perceive traditional foods with strong regard to their sensory properties (TRUEFOOD, 2009). Furthermore, innovation in traditional processes may be tolerated by the consumers as long as the food's intrinsic features (physical, chemical, microbiological or organoleptic) are maintained (EuroFIR, 2009). The production of traditional foods is perceived as sustainable and environmentally friendly, as well.

The environmental impact of the traditional food production is associated with various motives for food choice and consumption (Sibbel, 2007; Pieniaka *et al.*, 2009). Therefore, it is important that the environmental influence of the modified production steps in production of traditional food is not overlooked.

In order to improve the knowledge on environmen-

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tal impacts of current production systems and to find the solutions to reduce the negative impacts effective multi-approach environmental assessment methodologies are required. For this purpose, the life cycle assessment (LCA) – like approach was applied to studied changes in the process steps.

The environmental impact hot spots were identified in four model production lines prior to LCA assessment. These traditional production lines were reconstructed to represent European traditional food products in the sectors of dairy, meat, beverages and vegetables (Osojnik Črnivec & Marinšek-Logar, *in press*).

In the following article we report the LCA-wise case studies that were performed for the production steps within vegetable cultivation (fertility management) and within the production lines of hard cooked cheese (dairy cow nutrition and milking frequency) and dry-cured ham (curing mix manipulation).

2 METHODS

2.1 ENVIRONMENTAL IMPACT ASSESSMENT

Life cycle assessment – like approach was applied to studied changes in the process steps, as described in the previous article (Part I).

The experimental data obtained at INRA and IRTA (TRUEFOOD, 2009) was supported with the expert databases on e.g. fodder composition, nutrition data, weather data, soil characteristics and other. As the emission data was not directly available, initial parameters were coupled with models found in scientific literature for the emission inventory completion. The characterization to environmental impact categories was performed in accordance with available environmental impact assessment guidelines.

Emissions to air (greenhouse & acidification inducing substances) were assessed with the aid of EMEP/CORINAIR Emission Inventory Guidebook (2007) and the IPCC Guidelines for National Greenhouse Gas Inventories (2006).

The localization of eutrophication potential related emissions was performed with the use of preliminary results from the MITERRA-EUROPE (2009) database.

The final representation of the environmental impacts assessed was expressed per ton of food product and also per hectare of agricultural land (in the cases where agricultural production of the product was considered).

2.2 CASE STUDIES

The procedural principles of LCA were successfully applied to studies of innovative production steps of several traditional food production lines (Table 1). The case studies include the aspects of primary production (vegetable growing – fertilizer treatment, animal husbandry – nutrition and stable practices) and processing of the agricultural products (dry-cured meat) to traditional food products.

The first case study was based on fertilizer treatment field experiments conducted by the Spanish Institute for Food and Agricultural Research and Technology (IRTA). Several field experiments involved the cultivation of different *Brassica* varieties (Trevi, Meridien, Favola) and two fertilization treatments (organic fertilizer, manure – O; mineral fertilizer – M). While the mineral fertilizer (KH_2PO_4 135.9 kg/ha, NH_4NO_3 148.9 kg/ha, KNO_3 219.2 kg/ha, 20% N-solution 150 l/ha – Fig. 1) was applied according to usual farm practices, the organic treatment (80 t/ha) took place in a single application (Muñoz, 2009). The yields of different varieties differed significantly within and between the fertilizer treatments (approximate marketable yields t/ha: Trevi-O 8, Trevi-M 17,

Table 1: *Case studies considered in the framework of environmental impact assessment of traditional foods*
Preglednica 1: *Študije, vključene v ogrodje ocenjevanja vplivov na okolje v proizvodnji tradicionalnih živil*

			Agricultural & production practices	
Process	Case study	Region	traditional	alternative
Fertility management	Vegetable cultivation; *Brassica* sp.	Spain	mineral fertilizer treatment	organic fertilizer treatment
Feed ration composition	Vegetable oil supplementation; extruded linseed.	France	traditional ration	addition of extruded linseed
Milking frequency	Comparison of once and twice daily milking.	France	twice daily milking	once daily milking
Curing mix manipulation	Reduction of sodium chloride / substitution with potassium lactate.	Spain	high NaCl content in cured ham	reduction of Na^+ level

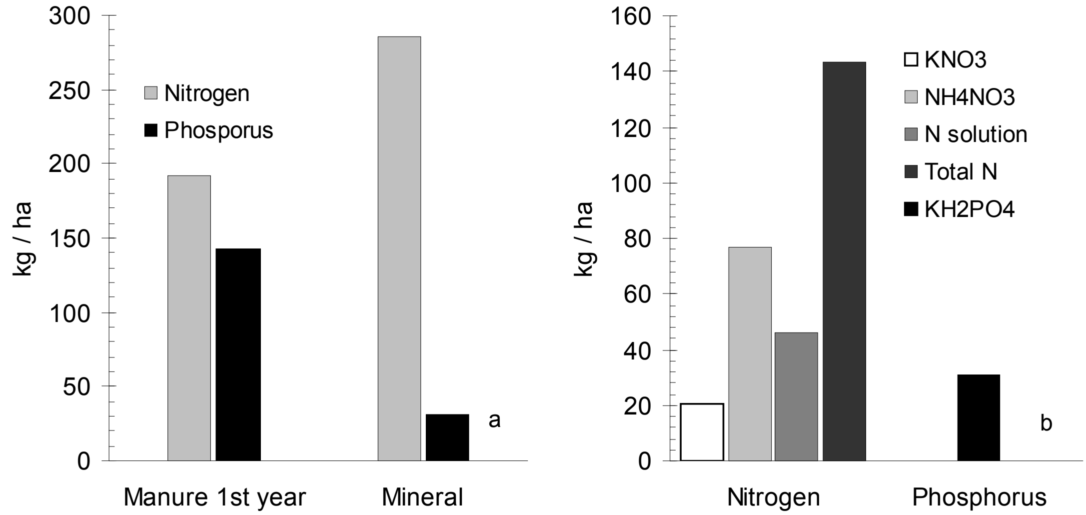

Figure 1: *N and P sources in the Brassica sp. field experiment (a – by type of fertilizer, b – by mineral fertilizer nutrient sources).*
Slika 1: *Viri N in P v poljskem poskusu gojenja Brassica sp. (a – po vrsti gnojila, b – po vrsti mineralnega gnojila).*

Meridien-O 10, Meridien-M 25, Favola-O 29, Favola-M 30).

The amount of nitrogen applied to the field with manure was high (app. 450 kg/ha), but the amount of N available to plants in the short-range is much lower (results for N available in the first year are presented in Fig. 1), thus the N utilized by plants / emitted to the environment is a part of the environmental impact balance of the forthcoming crops. Also, more phosphorus is applied by organic fertilizers than mineral, which can be problematic (due to nutrient loss) especially in P-rich soils. Further details about the experiment are described in the research reports (Alomar *et al.*, 2007; Doltra *et al.*, 2008).

The second case study was based on nutritional research carried out by the French National Institute for Agricultural Research (INRA). The experiments were focused on the effects of dairy diet supplementation with vegetable oil on the nutritional quality of dairy fat. The ration fed to cows was based on different amounts of hay, maize silage, cereal mix, soybean meal and extruded linseeds (with and without vitamin E). The composition of feed grouped by feeding regimes (C-control/traditional,

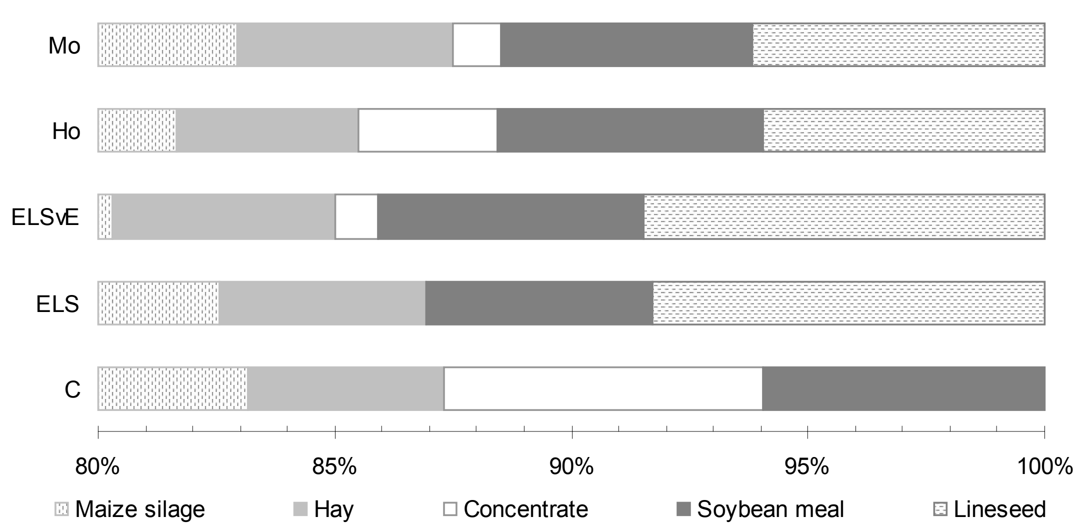

Figure 2: *Feeding ration composition (share of consumed fresh matter).*
Slika 2: *Sestava krmnih obrokov (delež zaužite krme).*

Table 2: *Contribution to environmental impact categories by fertilizer treatment*
Preglednica 2: *Doprinos h kategorijam vpliva na okolje po vrsti gnojila*

		GHG [eq. kg CO_2]		AP [eq. kg SO_2]		EP [eq. kg NO_3 [eq. kg PO_4]				LU [ha]
Variety	Treatment	/t	/ha	/t	/ha	/t	/ha	/t	/ha	/t
Trevi	Organic*	230	1 870	3.3	26.5	22.9	183	4.4	35.3	0.125
	Mineral	1 230	20 500	1.04	17.3	0.14	2.3	0.15	2.5	0.060
Meridien	Organic *	190	1 870	2.6	26.5	4.5	44	2.2	22.1	0.100
	Mineral	810	20 500	0.68	17.3	0.09	2.3	0.10	2.5	0.040
Favola	Organic *	60	1 870	0.9	26.5	0.5	13	0.6	19.2	0.034
	Mineral	680	20 500	0.58	17.3	0.08	2.3	0.08	2.5	0.033

*= emissions in the first year after application

ELS-with extruded linseeds, ELSvE-with extruded linseeds and vitamin E) or by breeds (Ho-Holstein, Mo-Montbèliarde) in the experiment is presented in Fig. 2. The first results showed no change in the dry matter intake, the milk yield and fat content. The nutritional composition of milk fat was improved, yet the animal weight and the milk protein content were depressed. Further details about the experiments are described in the research reports (Ferlay *et al.*, 2007; Martin *et al.*, 2008).

The third case study was based on a set of milking frequency observations carried out by INRA, likewise. The experiment consisted of three groups (TDM – cows milked twice daily/traditional, ODM – cows milked once daily, ODMc – cows milked once daily, with calves). The nutritional requirement of the diary cows in the ODMc group were subtracted the requirements for milk consumed by calves to create an additional 'calf-allocation' group, ODMc-a, for the calculation purposes. The cows were fed *ad libitum* with a pre-mixed ration of grass (20% on DM) and maize silage (25% on DM), hay (9% on DM), straw (3% on DM) and concentrates (3% DM on soy meal, 40% on DM on concentrate) (Pomiès, 2009). The modification of the nutritional quality of milk and the decrease of milk yield was demonstrated with the reduction of milking frequencies. Cows milked twice daily had an average yield of 33.66 (32.88 ECM) kg/d, the cows milked once daily with calves 14.68 (14.73 ECM) kg/d and without calves 21.90 (22.87 ECM) kg/d. Further details about the experiments are described in the research report (Martin *et al.*, 2007).

The last case study was based on experiments aimed to reduce the concentration of sodium chloride in dry cured ham, performed by IRTA. Potassium lactate was efficiently used as a substitute to Sodium chloride in ham cure. A salt reduction curing mixture (SR – 15 g NaCl / kg green ham) and salt reduction treatment with added K-lactate (SRL – 15g/kg NaCl, 39.7 g K-lactate / kg green ham) were tested in the experiment for their effect on weight loss and sensory characteristic. The traditional curing mixture (S), as described by Arnau (2007), contains 30g/kg green ham NaCl. Further details about the experiments are described in the research reports (Fulladosa, 2007; Gou, 2007; Serra, 2007).

3 RESULTS AND DISCUSSION

3.1 FERTILIZER TREATMENT

As the global warming potential and acidification potential were based on gaseous emissions from the field (usually prior to planting), these environmental categories are influenced in equal shares when expressed per area utilized and are lower for manure than mineral of agricultural utilization (Table 2). Expressed per ton of yield, GHG and AP expressed per ton of yield, the GHG and AP emissions are the lowest for the highest yield (Favola-O).

The environmental impact of fertilizer treatment is governed by excessive soluble nutrients and most of these nutrients appear to remain unexploited during manure treatment. This is evident especially in the case of Trevi variety, presumably due to the low yield and short time of growth.

Fertilizer production contributes less than 5% of GHG emissions (Fig. 3), more than 20% of AP (Fig. 4) and near 50% of EP (Fig. 5; due to low amount of NO_3 leaching) to the total environmental impact of mineral fertilizers.

According to EMEP/CORINAIR methodology, mineral fertilizer GHG emissions of mineral fertilizer application constitute of direct emissions of N_2O and additional indirect N_2O emissions for manure management (Fig. 3).

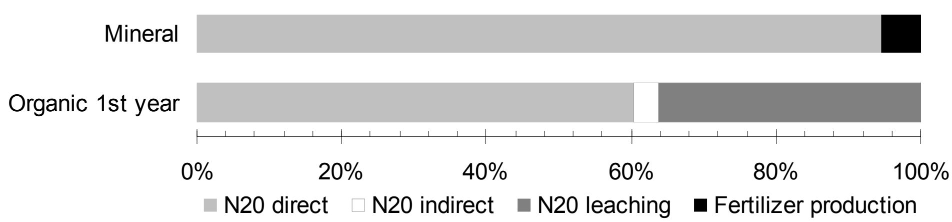

Figure 3: *Greenhouse gas emission (GHG) sources of fertilizer treatment.*
Slika 3: *Viri emisij toplogrednih plinov v povezavi z rabo gnojil.*

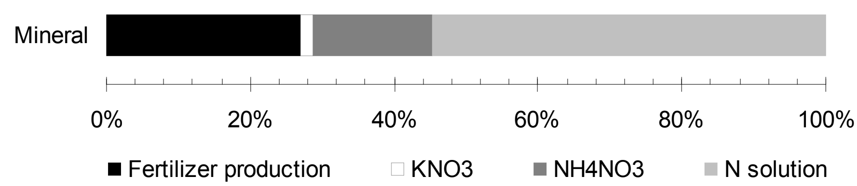

Figure 4: *Acidification potential (AP) sources of mineral fertilizer.*
Slika 4: *Emisijski viri kislega dežja v povezavi z rabo mineralnih gnojil.*

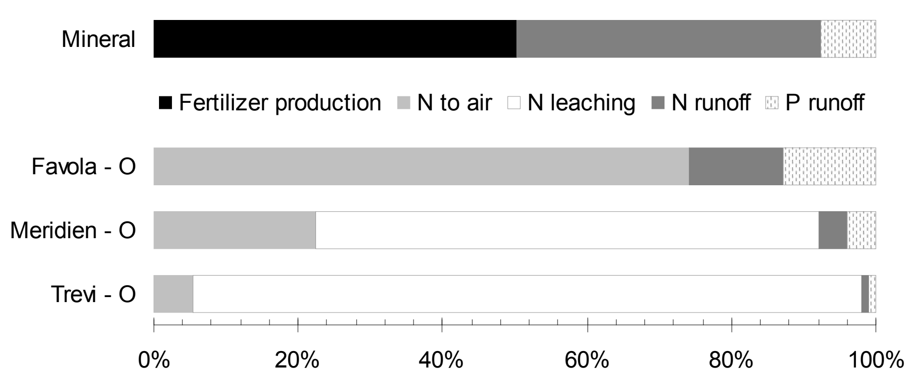

Figure 5: *Eutrophication potential (EP) sources of fertilizer treatment.*
Slika 5: *Emisijski viri prekomernega kopičenja hranil v okolju v povezavi z rabo gnojil.*

The acidification potential in this assessment is based entirely on ammonia gaseous emissions. The main contributor to these emissions for mineral fertilizer treatment is the application of N-solution (Fig. 4).

Nitrogen leaching, contributing to the EP, was assessed only in the cases of Meridien and Trevi varieties fertilized with manure (Fig. 5). In other cases, the assessed N-plant-uptake was exceeded or equal to the N-input. These results are quite consistent with the findings of Brentrup *et al.* (2004a) wheat production studies, which stated that at N rates higher than 144 kg N/ha, the eutrophication potential is dominated by NO_3 leaching.

The amount of gaseous loss of nitrogen is greatest during the denitrification and nitrification of mineral fertilizers (N_2O to air) and direct NH_3 emissions for manure application. The reduction of ammonia field volatilization with the incorporation within some hours after application is possible in the 10-fold range. However, practices that reduce the nutrient losses in one agricultural phase are increasing the input the next stage. To prevent the increase of emissions during growth, i.e. 'pollution swapping', the further steps should be optimized, too.

The ammonia emission from manure is governed by the type of manure (originating species and composition), type of soil, application regime, weather conditions (wind) and so on. Basing on the data provided by Smith *et al.* (2001a), we compared the application of farmyard manure (N input based on experimental conditions)

***Table 3:** Contribution to environmental impact categories of fodder production by feeding regime and breed*
***Preglednica 3:** Doprinos h kategorijam vpliva proizvodnje krmil na okolje glede na krmni obrok in pasmo*

	GHG [eq. kg CO_2]		AP [eq. kg SO_2]		EP [eq. kg PO_4]		[eq. kg NO_3]		POCP [eq. kg TOPP]		RU [MJ CEU]	
Group	/t	/ha	/t	/ha	/t	/ha	/t	/ha	/t	/ha	/t	/ha
C	180	2 290	1.20	15.6	0.035	0.45	0.36	4.6	0.71	9.2	1 840	23 830
ELS	180	1 550	1.18	10.2	0.083	0.72	0.88	7.5	0.43	3.7	3 990	34 340
ELSvE	190	1 600	1.29	10.7	0.088	0.73	0.93	7.6	0.46	3.8	4 220	34 820
Ho	180	1 740	1.22	11.6	0.071	0.67	0.74	7.0	0.51	4.9	3 430	32 790
Mo	190	1 680	1.28	11.2	0.077	0.68	0.81	7.1	0.53	4.6	3 730	32 820

with the autumn application of slurry. The N-runoff from farmyard manure was lower (higher DM and lower urea content) in the cumulative N-runoff. The assessed runoff of NO_3 after application is similar for the studied organic fertilizers, yet the runoff ammonia emissions of farmyard manure are superseded by the surface draining of slurry ammonia. Also, the runoff of NO_3 dominates the total N-runoff in the applied mineral fertilizer array (results not shown).

The traditional mineral fertilizer treatment in this experiment conveys higher GHG emissions and lower AP, EP and LU values than manure application.

The application of manure was most environmentally efficient in the Favola-O scenario, where the marketable yield of cauliflower had least declined comparing to the yield of Favola fertilized with mineral fertilizers.

3.2 VEGETABLE OIL SUPPLEMENTATION

The global warming potential of the »traditional« diet production (group C) was amongst the lowest expressed per fodder consumed in one day or fodder consumed per ton ECM. However, per ha, the level of GHG emissions was noticeably higher than in other groups (Table 3). This is presumably due to cereal mix (group C) substitution with linseed (Fig. 2). The same relation can be observed for the acidification (AP) and photochemical ozone creation potential (POCP). In cases of eutrophication potentials (EP), land use (LU) and resources use (RU), group C remains most efficient.

The production of feed consumed for the production of 1ton ECM required 0.0774 ha land in group C, 0.1160 ha in group ELS, 0.1210 ha in group ELSvE. The amount of feed consummated by the dairy cows to produce 1 ton of ECM was produced on 0.1050 ha land for Holstein and 0.1140 ha for the Montbèliarde breed.

The supplementation of linseed increases the resources used for feed production, the eutrophication potential and the use of land, as this crop has a much smaller yield than maize and barley used in the cereal mix.

The Montbèliarde breed appears to have a lower capability of feed conversion and therefore bares higher environmental impacts per ton ECM yield than the Holstein breed.

The majority of the environmental impacts arise from the animal breeding phase (on average 71.8% of total GHG, 92.9% of AP and 98.8% of EP).

The manure management accounts for 30% and enteric fermentation for 70% of the greenhouse gas emissions in animal production. Under the determined conditions, more than half emissions of ammonia con-

***Table 4:** Contribution to environmental impact categories of animal breeding by feeding regime and breed*
***Preglednica 4:** Doprinos h kategorijam vpliva reje živali na okolje glede na krmni obrok in pasmo*

	GHG [eq. kg CO_2]		AP [eq. kg SO_2]		EP [eq. kg PO_4]		[eq. kg NO_3]		LU [ha]
Group	/t	/ha	/t	/ha	/t	/ha	/t	/ha	/t
C	500	2 846 000	17.5	992 600	5.8	332 200	61.6	3 498 000	0.21
ELS	440	25 760 000	14.7	862 700	5.4	314 600	56.5	3 311 000	0.20
ELSvE	470	25 760 000	16.3	902 200	5.9	325 000	61.9	3 421 000	0.22
Ho	460	29 280 000	15.4	992 800	5.5	354 300	57.9	3 729 000	0.19
Mo	490	24 250 000	17.3	857 300	6.1	301 500	64.0	3 173 000	0.24

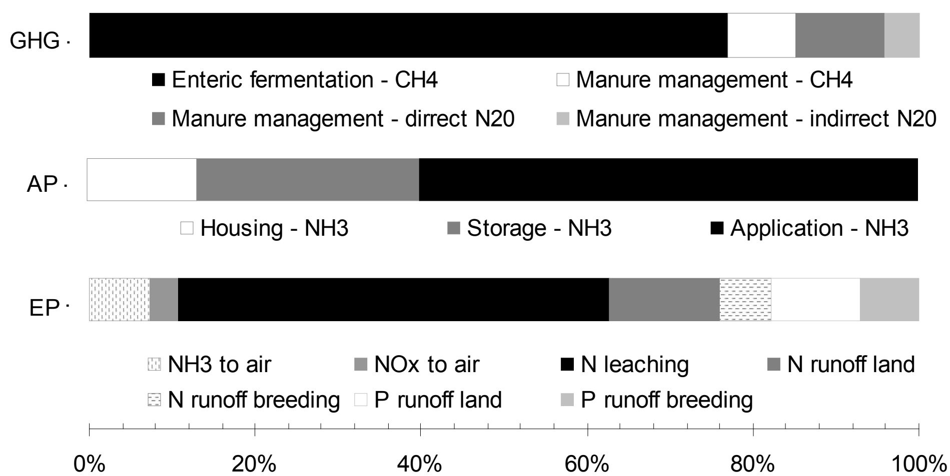

Figure 6: *Major sources of environmental impacts in animal husbandry.*
Slika 6: *Večji viri vpliva reje živali na okolje.*

tributing to the acidification potential occur after application of manures to agricultural areas, a third during storage and the least is volatized in the stable (Fig. 6).

The overall assessment is favourable towards the vegetable oil supplementation from the viewpoint of GHG emissions and AP (10% and 11% average reduction during animal production, respectively).

On the other hand, linseed production requires more energy resources and similar EP and LU than the utilization of the traditional diet. This can be compensated with the use of renewable energy resources and with the purchase of locally produced linseed (for energy), breed selection, nutrition balancing and optimization of agricultural practices (for eutrophication potential) to reduce the environmental impact budget of the innovative production step.

3.3 ONCE DAILY MILKING

As the TDM group produced the most milk and consumed the most fodder, their absolute environmental impact (per day) was the highest. Expressed per production of milk, the environmental impact for production of feed consumed in the TDM group is the lowest (Table 5). The grounds are nutritional as the cows that produce less milk have more or less the same amount of nutrient requirements for maintenance than cows with a higher amount of milk. When the milk yield decreases the feed consumed for maintenance purposes becomes more evident. The high environmental impact levels of the ODMc group are biased. The bias is revealed by assigning the difference to rearing calves (ODMc-a).

Whilst the cow-ration was pre-mixed and fed *ad libitum* the composition of the feed is uniform. Therefore, the EI expressed per agricultural area used to produce the feed does not vary amongst different test groups and is as follows; 1803.9 eq. kg CO_2 / ha (GHG), 10.70 eq. kg SO_2 / ha (AP), 0.38 eq. kg PO_4 / ha & 3.96 eq. kg NO_3 / ha (EP), 6.58 eq. kg TOPP / ha (POCP), 15872.71 MJ CEU / ha (RU).

The environmental impact of individual feed component is disproportionate to its consumed share and is not uniform amongst the environmental categories (Ta-

Table 5: *Contribution to environmental impact of fodder production by milking regime per t ECM*
Preglednica 5: *Doprinos h kategorijam vpliva proizvodnje krmil na okolje glede na pogostost molže na t ECM*

Group	GHG [eq. kg CO_2]	AP [eq. kg SO_2]	EP [eq. kg PO_4]	[eq. kg NO_3]	POCP [eq. kg TOPP]	RU [MJ CEU]	LU [ha]
TDM	180	1.0	0.037	0.39	0.64	1550	0.97
ODM	240	1.4	0.050	0.52	0.86	2080	0.13
ODMc	390	2.3	0.083	0.86	1.42	3430	0.22
ODMc-a	300	1.8	0.063	0.65	1.08	2600	0.16

Table 6: *Contribution to environmental impact categories of animal breeding by milking regime*
Preglednica 6: *Doprinos h kategorijam vpliva reje živali na okolje glede na pogostnost molže*

	GHG [eq. kg CO_2]		AP [eq. kg SO_2]		EP [eq. kg PO_4]		[eq. kg NO_3]		LU [ha]
Group	/t	/ha	/t	/ha	/t	/ha	/t	/ha	/t
TDM	460	29 960 000	13.3	863 600	4.7	303 300	49.3	3 193 000	0.15
ODM	630	27 700 000	19.1	845 000	6.6	291 200	69.4	3 066 000	0.27
ODMc	1040	29 230 000	32.9	924 100	11.2	315 200	118.1	3 318 000	0.43
ODMc-a	790	22 160 000	25.2	708 400	8.5	240 000	89.9	2 526 000	0.43

ble 5). The concentrate production carries the bulk of impacts. The impact of soybean is also excessive, yet it is not immediately noticeable since the amount of soy consumed is very small.

Greater daily emissions arise from the agricultural animal breeding practices (on average 72.6% of total GHG, 93.2% of AP and 99.2% of EP).

Similarly to diet production, the environmental impact of the least productive group is the highest expressed per yield of milk (increase of GHG 77%, AP 193%, EP 88%, LU 103%; average % of environmental impact change comparing to traditional TDM) whereas per ha of agricultural area, the levels of environmental impact are equalized or inverted amongst the groups (reduction of GHG 12%, AP 4%, EP 7%; average % of EI change comparing to traditional TDM). This relationship (Table 6) is in accordance to the findings of De Boer (2003) whilst comparing the environmental impact of conventional and organic dairy farming.

Therefore, the measures for environmental impact reduction to compensate for the higher environmental impact of the once daily milking frequency (per milk amount) should be focused on altering the production practices related to nutrition, animal housing and manure.

3.4 ADDITION OF POTASSIUM LACTATE

The environmental impact of lactic acid dominates the EI of the potassium lactate production in all the environmental categories (Fig. 7), since considerable amounts of resources are used in the cultivation and fermentation of sugars. However, as sugars are acquired from plant biomass and renewable energy can be used, the GHG potential of lactic acid production is negative (Vink *et al.*, 2003; Vink *et al.*, 2007).

The environmental impacts related to production of potassium lactate are very low (negative for GHG, some 10^4 ranges greater for AP, EP and POCP and approximately 10 times more energy consuming) comparing to the production of the same amount of NaCl (Fig. 8).

The change in the weight loss does not affect the environmental impact of different cure mixture in the sense of changing the environmental impact relationship levels (Table 7). The traditional cure mix (S) has the highest

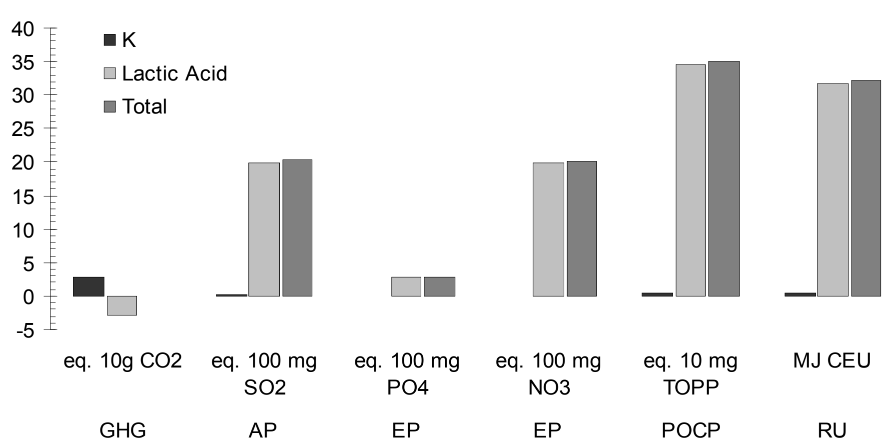

Figure 7: *Environmental impact of potassium lactate component production (/ kg potassium lactate).*
Slika 7: *Vpliv proizvodnje komponent kalijevega laktata na okolje (/kg kalijevega laktata).*

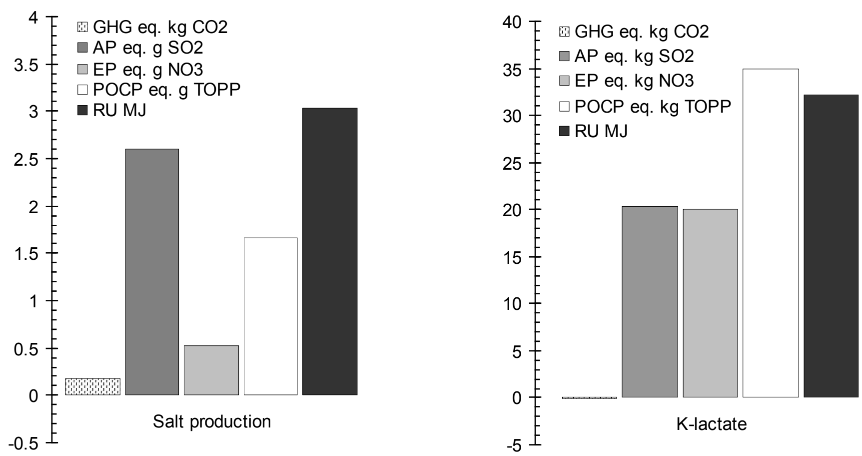

Figure 8: *Comparison of the environmental impact of NaCl and K-lactate production (note – different scales are used in the graphs).*
Slika 8: *Primerjava vplivov proizvodnje NaCl in K-laktata na okolje (pozor – primerjavi sta prikazani na različnih merilnih skalah).*

global warming potential, and has higher environmental impact levels than the reduced salt cure (SR) and lower levels than SRL for all others environmental impact categories. The higher amount of energy and resources used for the production of K-lactate (Fig. 8) is evident also in the empirical conditions (Table 7). Being the global warming potential of K-lactate production low (Fig. 7), the GHG emissions of SLR are similar to SR values (Table 7).

Therefore, the SR technique is the most acceptable from the viewpoint of environmental impacts. Environmentally more suitable curing mixture, containing K-lactate, requires further reductions of other curing components. However, an entirely equivalent environmental impact to the traditional cure mix could be difficult to achieve.

4 CONCLUSIONS

The individual arrays of procedures paired to meet the demand of study-specific environmental assessment were successfully applied to production steps studied.

In the *Brassica* sp. field tests, the traditional mineral fertilizer treatment exhibited higher GHG emissions and lower AP, EP and LU values than manure application. The application of manure was most environmentally efficient for the Favola high-yield variety. However, in our opinion, it is important to consider the environmental impacts of other fertilizer treatments (e.g. the combination of mineral and organic fertilizers, anaerobically treated organic manures, green manures …).

As linseed has a much smaller yield than maize and barley used in the cereal mix, the supplementation of linseed increases the resources used for feed production, the eutrophication potential and the use of land. Yet, the overall assessment is favourable towards the vegetable oil supplementation from the GHG emission and AP point of view. Should the data be available, it is important to consider the flax variety grown for the supplementation (intended only for seed / or also for the production of fibre).

The milking once a day appears to be environmentally friendly when the values per agricultural land used or daily values are observed. Nevertheless, the higher environmental profile of this group is revealed, when the

Table 7: *Contribution to environmental impact categories of cure mixture manipulation*
Preglednica 8: *Doprinos h kategorijam vpliva spreminjanja sestave zorilne mešanice*

Group	GHG [eq. kg CO_2]		AP [eq. kg SO_2]		EP [eq. kg PO_4]		[eq. kg NO_3]		RU [MJ]	
	/t green ham	/t cured ham	/t green ham	/t cured ham	/t green ham	/t cured ham	/t green ham	/t cured ham	/t green ham	/t cured ham
S	5.5	8.4	0.078	0.118	0.00100	0.00152	0.0158	0.024	0.050	0.075
SR	2.8	4.0	0.039	0.057	0.00050	0.00073	0.0079	0.012	0.025	0.036
SRL	2.8	4.1	0.087	0.129	0.00727	0.01078	0.0553	0.082	0.108	0.159

environmental impact is expressed per milk amount. Once the milk ingredients have been standardized with the energy corrected milk equation the increase of the ingredients due to the decrease of the milking frequency does not compensate for the higher environmental impact linked with animal breeding.

The sodium chloride reduction cure was the most efficient, environmental impact wise. The production of potassium lactate employs several material and energy resources. Therefore, an entirely equivalent environmental impact to the traditional cure mix could be difficult to achieve with the cure containing potassium lactate. Nevertheless, the dietetic effects of the potassium lactate could prove to be an important advantage for the use in food products.

POVZETEK

V prvi fazi smo na primerih uvajanja inovacij v proizvodnje linije v proizvodnji tradicionalnih živil (sir, pršut, cvetača) uredili metodološko ogrodje za ocenjevanje vplivov na okolje. Nadalje smo preverili ustreznost pristopa in na podlagi predhodno vzpostavljenega metodološkega ogrodja ocenili vplive posameznih proizvodnih korakov obravnavanih primerov na okolje.

Ti, za študije-specifični protokoli presoje vplivov na okolje in uporabljeni modeli ter baze podatkov, so primerni tudi za kasnejšo pripravo smernic in za poročanje o vplivih na okolje na obravnavanih področjih kmetijske dejavnosti in proizvodnje živil.

Končne ocene okoljskega vpliva smo obravnavali z vidika količine živil (/t izdelka) in z vidika rabe kmetijskih zemljišč (/ha, v tistih primerih, v katerih smo upoštevali kmetijsko proizvodnjo).

V poljskem poskus gojenja cvetače ima raba mineralnih gnojil večji potencial za globalno segrevanje ter nižje potenciale za tvorbo kislega dežja ter prekomernega kopičenja hranil. V splošnem je bila raba gnojil okoljsko najbolj učinkovita za varieteto Favola z visokim hektarskim donosom.

Dokrmljevanje ekstrudiranega lanenega semena se v proizvodnji krme kaže na povečani rabi naravnih virov, kmetijskih površin in povečanem potencialu za prekomerno kopičenje hranil. Lan ima namreč precej manjši hektarski donos kot koruza in ječmen, ki sta bila sicer uporabljena v koncentratu. Celokupno je dokrmljevanje lanenega senu upravičeno z vidika toplogrednih emisij in potenciala za tvorbo kislega dežja.

Na prvi pogled molža enkrat na dan okolje v obravnavanih kategorijah obremenjuje v manjši meri kot molža dvakrat na dan. Zaradi skorajda enakih vzdrževalnih potreb krav molznic v obeh eksperimentalnih skupinah, pa so ocene vpliva pogostnosti molže na okolje mnogo nižje pri živalih, ki so jih molzli dvakrat dnevno.

Z okoljskega vidika je najbolj ugodna sestava zorilne mešanice z manjšo količino natrijevega klorida, kot je običajna v tradicionalnih mešanicah in brez dodatka kalijevega laktata. V proizvodnji kalijevega laktata je poraba materialnih in energetskih virov precej večja kot v pridelavi soli. Z vsakršnim dodatkom kalijevega laktata je zato težko doseči popolni okoljski ekvivalent mešanicam z vsebnostjo kuhinjske soli. Toda v končni fazi vrednotenja ugodnih in neugodnih učinkov te proizvodnje linije ne smemo zanemariti dietetičnih učinkov kalijevega laktata.

ACKNOWLEDGEMENTS

The authors acknowledge the TRUEFOOD-“Traditional United Europe Food”, an Integrated Project financed by the European Commission under the 6th Framework Programme for RTD (contract n. FOOD-CT-2006-016264). The information in this document reflects only the authors’ views and the Community is not liable for any use that may be made of the information contained therein.

The contributions of the TRUEFOOD partner institutions which have provided basic experimental and process data, especially the Institute for Food and Agricultural Research and Technology and the French National Institute for Agricultural Research, are kindly acknowledged. The detailed results of the experiments are not part of this evaluation and should be obtained from the TRUEFOOD project or their appropriate partners.

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