Biotechnology in Animal Husbandry 31 (1), p 1-12 , 2015
Publisher: Institute for Animal Husbandry, Belgrade-Zemun
ISSN 1450-9156
UDC 631.84'862
DOI: 10.2298/ BAH1501001K

ECOLOGICAL TRENDS AT ANIMAL HUSBANDRY NITROGEN UTILIZATION

K. Krastev

Institute of Animal Science, Kostinbrod, PC 2232, Bulgaria
Corresponding author: eko@mail.bg
Original scientific paper

Abstract: The aim of current work was a part of study for animal husbandry effects on emissions of greenhouse gases and some mitigation strategies between the end of XX and the beginning of XXI century. It's emphasized on nitrogen (N) balance and its fluctuated values, as well as brings forward attendant factors. As a result, we deducted strong correlation models (R^2> 0.89, 0.85, 0.99), as an estimator of the N_2O emissions ($Gg.CO_2^{-eq}$), generated by manure management in relation to animal population (monogastric, ruminant, total) among the investigated middle-term periods throughout 1989 – 2011 y for the Bulgarian realities.

Key words: agro-ecological, strategies, microclimate, ammonia, manure, farming, balance, animal, population

Introduction

The microclimate pooled physical (temperature, humidity, air flow), chemical (toxic gases) and biological (bacteria, viruses, fungi) factors. It's influenced animal health status, e.g. animal performance and could be assumed as an important livestock stressor (*Morgan and Tromborg, 2006*). The productive systems and technologies determined limiting factors as breeding and nutrition strategies, environmental conditions, production need, etc. to be taken into account. In this regards must be promoted the following role „*hygiene = health = efficiency = profitability*".

Thereby, the common air gases pollutants are ammonia, carbon dioxide, hydrosulphide and methane. The atmospheric ammonia concentrations developed animal response in terms of health problems and reduced performance. Thus, we emphasized on a number of worldwide and local mitigation strategies (genetic, nutritional, herd, technological, etc.) and some ecological aspects of ammonia.

The ammonia is a strongly alkaline, colourless, soluble in water and with irritant odour gas. Its molecular weight (17.03), absolute (0.771) and relative to air ($0.5967 g.l^{-1}$) density under pressure liquidified at ammonium hydroxide. The main concentrations of atmospheric ammonia are generated from animal manure as excreted fecal protein-N and urinary urea-N. These amounts are bio-transformed by bacterial urease enzymes at high temperature (49 ^{o}C) and alkaline optimum (7.7 – 8.0 units).

The amounts generated by manure and the rate and extent parameters depends on the equilibrium in the liquid – gas phase as follow (Eq. 1):

$$NH_4^+ \longrightarrow NH_3 + H^+ \quad (1)$$

The air ammonia emissions could be calculated by different exemplified data models (as software Package *STANK, 1999; HadCM3, 2007* etc.) for ammonia losses from livestock manure (fig. 1), but can depict the situation and Bulgarian

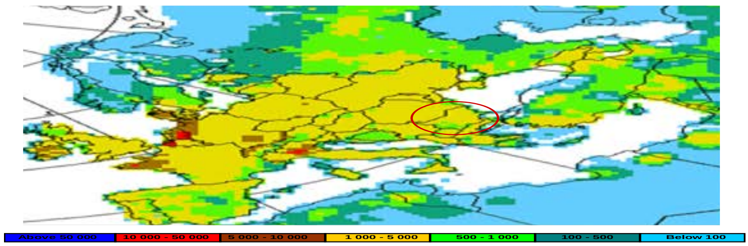


Figure 1. Ammonia emissions (50 km x 50 km EMEP grip, 1997)

place also in regards to ammonia losses among livestock species distributed as follow percentage ranges:

- cattle – 68 %;
- pigs – 15%;
- other – 17 %.

The manure management could be used as a beneficial tool for a sustainable farming system with environmental-friendly practices (*Van Passel et al., 2007*) maintaining the European Common Agricultural Policy. As a support of this, the manure ammonia losses from different livestock species and categories within the barn, we could depicted the situation with, as a percent of total manure N content, summarized on following graph – fig. 2:

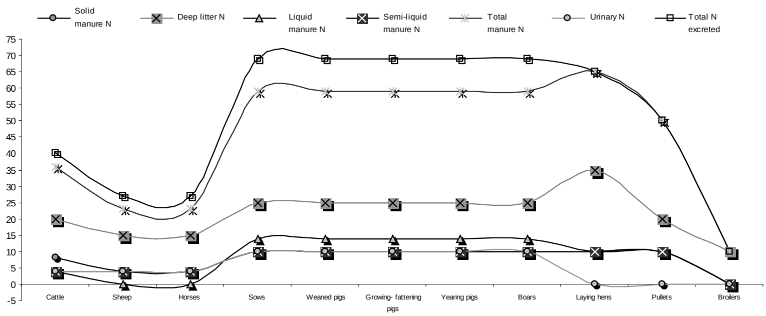


Figure 2. Different forms of manure ammonia losses from different livestock species and categories within the barn (% of total nitrogen content of the manure, STANK 1999)

The diets, provided for productive animals are formulated to maintain higher productivity based on economic limits and ecological restrictions. Likewise, the dietary protein inputs affected total tract protein digestibility and modified the ratio fecal-N/urinary-Noutput (N_f/N_e) (*Accioly et al., 2002; Yossifov and Kozelov, 2011; Yossifov and Kozelov, 2011a; Yossifov, 2014a*). An admitted pollutant values for ammonia are summarized in table below (*Bulgarian Regulation N44, 2014*):

Table 1. Optimal microclimate standards in animal vitality zone - ammonia*

Species NH_3	(mg/m^3)	(ppm)
R u m i n a n t s		
Cattle	up to 20	up to 28.7
Buffalo	up to 20	up to 28.7
S m a l l r u m i n a n t s		
Lactating	up to 10	up to 14.4
Suckling	up to 10	up to 14.4
Fattening	up to 10	up to 14.4
Yearling	up to 10	up to 14.4
M o n o g a s t r i c		
Pigs	up to 5	up to 7.18
Birds		
Turkey	up to 15	up to 21.5
Goose	up to 15	up to 21.5
* Bulgarian Regulation N44-20/04/2006 (2014)		

As a result, the surpass air ammonia values affected animal welfare and animal response (*CIGR*, *1984*). In this regards, we aimed to investigate the animal husbandry effects on emissions of N-related greenhouse gases. It's emphasized on nitrogen (N) balance, agro-ecological fluctuates and mitigation strategies, as well as brings forward attendant factors for the middle-term period throughout 1989 – 2011. Also, we underlined on a number of worldwide and local mitigation strategies (genetic, nutritional, herd, technological, etc.) and some ecological aspects of ammonia.

Materials and Methods

We conducted our study based on following items, contributed to the ammonia losses, associated with livestock farming management:

2. Dietary protein supply – content, subfractions, etc.;
3. Species, categories, individuals, etc.;
4. Farm building management;
5. Manure management – content, storage, conditions, etc.;
6. Manure N content – fractions, spreading, etc.

All obtained data were equalized by *NISTC (2014).* The values were interpreted and correlated by Statistical Package of *MS, 2007*.

Results and Discussion

The flows and cycling of biogenic nutrients – i.e. nitrogen (N), carbon (C), potassium (K), phosphorus (P), and their excessive levels are preconditions to generate ecological problems. Also, the cumulative capacity of N- (NH_3, N_xO_x, NO_3^-), C- (CO_2, CH_4), P- containing (P_xO_x), and K^+ derivatives in atmosphere lead to disproportion and imbalance, resulting in disturbed ecosystem stability. But, the productive systems affecting environment in different order (*Steinfeld et al., 2006*). Thus, the main emissions of gases in ruminant sectors are related to N, as limiting factor (*Bouwman et al., 1997*). Near ½ of greenhouse gases emissions from agriculture (5 %) in EC_{28} are generated by enteric fermentation and manure management (*Freibauer, 2003; European Environment Agency, 2013*). Also, Bulgarian values are near to EC_{28} means (near 10 and 5 % for gases emissions from agriculture and total amounts from enteric fermentation (near 1/3 of emissions from agriculture) and manure management (near 1/6 of emissions from agriculture), respectively).

The leading negative effects of animal husbandry and agriculture could be summarized as a source of different atmospheric pollutants by various nature – chemical, physical, biological, etc. (*Foer, 2009*). The feed lot and dairy industries excreted 27.1 кg CO_2 Eq /кg feed intake and 39.3 кg from total gases emissions (*Hamerschlag and Venkat, 2011*). Likewise, the animal husbandry sector is common environmental pollutant, e.g. source of ecological risks (*Steinfeld et al., 2006*). Therefore, we awaited harmer scenarios with deeper problems, because the future prognosis indicated food production (meat and milk) to be increased at twice till 2050[s] (*www.fao.org*). The total amount of greenhouse gases emissions, estimated as CO_2 Eq, are near 18 %, and 4.6 billion t CO_2 Eq are generated in EC_{28} (*European Environment Agency, 2013*). Also, the 4th Assessment Report of the Intergovernmental Panel of Climate Change (*AR4*) generalized the atmospheric concentrations increment: CH_4 – doubled, CO_2 – by 35%, N_2O – by 18%, compared with the pre-industrial era (*IPCC, 2007*). Thus, in terms of Common Agricultural Policy (*CAP, 2014-2020*) and under the limitations and requirements of *Nitrate Directive* (*1991*), and *Bulgarian Regulation N44-20/04/2006* (*2014*) farmers must to control their N flows and cycling (*EC, 1991; COM, 2006*). Otherwise, the environmental pollution with agricultural N becomes from imbalanced cycling at input/output criteria. The N excretion, as a function of input/output ratio, is related with breeding and nutritional systems, physiological status, environmental conditions, etc. So, the manipulation of these factors could modify animal production systems by increasing N utilization and decreasing N pollution.

The N levels, at Earth layers, are established as 4×10^{21} g. The reactive form (reactive N), as N-fixing organisms, is calculated under 1 % (*Mackenzie, 1998*). Simultaneously, the total amounts of excreted N in animal husbandry, is estimated on 75 $Tg.y^{-1}$ (*Smil, 1999*). So, the ammonia values, as a part of undesirable atmospheric components, are affected by N utilization in farming sector (*Bussink and Oenema, 1998; James et al., 1999*). The low N efficacy is based on higher input levels of crude protein in ruminant diets, e.g. higher output values of excreted N as fecal-N and urinary-N. It's proved by evidence that increased dietary protein per 1 % was followed by $2.8 g.d^{-1}$ and $35.7 g.d^{-1}$ acceleration in milk N and excreted urinary and fecal N (*Hristov and Huhtanen, 2008*). This confirmed the models from last 50[s] y at the XX_s century. So, dairy nutrition provided dietary N/milk N ratio near 2 at the ends of the 40_s, and increased up to 7 at the end of the period (*Ketelaars and Van de Ven, 1992; Rotz, 2004*). The leading role in this process was a result of intensification in animal husbandry and farming sector, e.g. constantly increased consumer requirements to achieve unreal levels of animal performance and productivity in short-term periods.

The excessive dietary protein supply in ruminant nutrition with higher N excretion resulted in subsequent ammonization of run-off water, atmospheric ammonia and nitrate contamination, and ecosystem acidulation and eutrophication (*Galloway and Cowling, 2002*). Simultaneously, the N_2O and NO_3^- concentrations correlated positively with the level and rate of N fertilization, and fertilizer' N amounts (*Tamminga, 2003*).

The right approach to the problem might be found with modified productive systems in regards to breeding (*Yossifov, 2014c*), scheme of weaning (*Yossifov, 2013; Yossifov and Kozelov, 2013; Yossifov and Kozelov, 2013a*), diet balancing (*Kozelov and Yossifov, 2013*), zoo-hygiene conditions (*Krastev and*

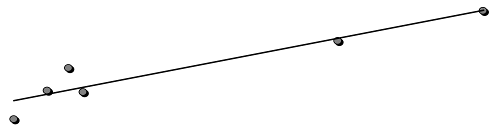
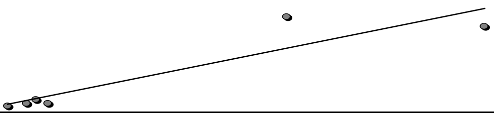
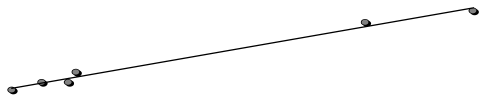
Petrova, 2000), etc. biotic and abiotic factors. In some articles, aimed at N balance estimation (*Yossifov and Kozelov, 2011; Yossifov and Kozelov, 2011a; Yossifov, 2013b; Yossifov, 2014a; Yossifov, 2014b*) in regards to dietary incorporation of non-traditional and alternative protein forages in feedlot (*Erickson et al., 2000; Yossifov et al., 2012; Yossifov and Kozelov, 2012a*) and dairy (*Kohn et al., 1997; Yossifov, 2012a*) productive systems exhibited adequate terms of reference to so called smart farming and excellent agriculture, based on precision balanced diets (*Rotz, 2004*). The perspective drawings and situations, based on decelerated intensification in agriculture, and aspects of biological farming systems and its subdivisions (*Yossifov, 2014d*), are oriented to achieve sustainable ecosystems related to co–factorial symbiosis in terms of agronomic, ecological, economic, social, etc. (*Van Passel et al., 2007; Yossifov, 2014e*). Nevertheless, animal husbandry sector, as a result of intensification in productive systems, generated near 65 % N_2O, 64 % NH_3, 37 % CH_4, and 9 % CO_2, excreted by human activities (anthropogenic) in the sector. Also, the total amount of generated CH_4 и N_2O emissions in EC_{28} are 194 and 271 million t, respectively (*European Environment Agency, 2013*). Thus, our efforts are exerted to different mitigation strategies and environment protection (*Meadows et al., 1992*). The main tools to decrease EC_{28} emissions of greenhouse gases are based on (*Tamminga, 2003*):

- Population / herd management (*St Pierre and Thraen, 2001*);
- Efficiency of farming systems and productive systems (*Kozelov and Yossifov, 2013*);
- Excellent agriculture, smart farming and precision balanced diets (*Jonker et al., 2002; Avery, 2010*);
- Reduced N-containing fertilizers (*CEAS/EFNCP, 2002*);
- Effective manure management practices (*Ipharraguerre and Clark, 2005*).

The main decisions must be made for more effective and profitable productive systems, based on precision and balanced feeding (*Avery, 2010*). As we mentioned above, farming systems (feedlot and dairy) are ineffective N consumer. This misbalancing employment of N, as a result of disturbed input/output ratio, related to amount of retained N (milk and meat) and N costs for expensive protein forages and excessive N fertilization (*Yossifov, 2013c*). Environmental pollution related to enormous N losses inside the cycling units and between the nutrient flows, based on poor manure management, accelerated N excretion, etc. The goals of the nutritionists' exerted efforts will be to balance livestock diets' by cheapest N sources (*Yossifov, 2013c*) with digestibility surpassed traditional ones (*Kozelov and Yossifov, 2013*). These efforts will gain higher N retention (milk, meat) or lower N excretion either (*Yossifov, 2012a; Yossifov, 2014a*). The potential benefits with better utilization of dietary N will modified both ecological and economic effects (*Oenema and Pietrzak, 2002*). Also, the N biotransformation must be expected at N fixation (N compounds), ammonification (air NH_3), nitrification (water NO_3^-) and denitrification (N_xO_x) processes.

Our database shown that an overall emission reduction in the agriculture amounted to 70 % in the period 1989 – 2011, and 2011 the sector contributed 9 % to the total of the Bulgaria' GHG_s. The downward trends were driven by livestock population and arable land reduction (table 2). The most important agricultural categories as well as the contribution to the total GHG emissions 1989 – 2011 are agricultural soils (58 %), enteric fermentation (21 %), manure management (19 %).

Table 2. Correlation model – animal population per period (thous)/ N_2O values ($Gg.CO_2^{-eq}$), as generated by Bulgarian manure management

Population (thous) / $Gg.CO_2^{-eq}$ N_2O	Year *1989 1991 1997 2001 2007 2011*	R^2
Monogastric		0.89
Ruminant		0.85
Total		0.99

A good parity between investigated parameters was observed among the deducted correlation models. The regressive analysis shows that estimated N_2O values ($Gg.CO_2^{-eq}$), as emissions generated by manure management (y) are manifested by close relationship with animal population (x) among the investigated middle-term periods throughout 1989 – 2011 y. The smooth diversion rate among the investigated parameters allows being comparable with strong correlation (R^2> 0.85 – 0.99).

Conclusion

The N excretion, as a function of input/output ratio, is related with breeding and nutritional systems, physiological status, environmental conditions, etc. So, the manipulation of these factors could modify animal production systems by increasing N utilization and decreasing N pollution. The main decisions must be made for more effective and profitable productive systems, based on precision and

balanced feeding. In regards to deducted correlation models, as an estimator of the N_2O emissions ($Gg.CO_2^{-eq}$), generated by manure management (*y*), are manifested by close relationship with animal population (*x*) among the investigated middle-term periods throughout 1989 – 2011 y for the Bulgarian realities.

Ekološki trendovi korišćenja azota u stočarstvu

K. Krastev

Rezime

Cilj ovog istraživanja je bio deo ispitivanja uticaja stočarstva na emisiju gasova staklene bašte i nekih strategija ublažavanja tog uticaja na kraju XX i početkom XXI veka. Pažnja je usmerena na ravnotežu azota (N) i njegove oscilirajuće vrednosti, kao i prateće faktore. Kao rezultat, utvrdili smo jake modele korelacije (R^2> 0,89; 0,85; 0,99) kao estimatorom emisija N_2O ($Gg.CO_2^{-eq}$), nastalu upravljanjem prirodnim đubrivom/stajnjakom u odnosu na životinjske populacije (ne-preživare, preživare, ukupno) u ispitivanim srednje-ročnim periodima tokom 1989 - 2011 god. u Bugarskoj.

References

AVERY D. (2010): Confined Livestock Better for the Planet. Center for Global Food Issues, Accepted on: 13/12/2011.

BOUWMAN A., LEE D., ASMAN W., DENTENER F., VAN DER HOEK K., OLIVIER J. (1997): A global high-resolution emission inventory for ammonia. Global Biochem. Cycles, 11, 561-587.

BULGARIAN REGULATION N44-20/04/2006. (2014): Veterinary requirements in farming, Ed. 21/02/2014. Optimal microclimate standards in animal vitality zone, Appendix 2-9.

BUSSINK D., OENEMA O. (1998): Ammonia volatilization from dairy farming systems in temperate areas: a review. Nutr. Cycling Agroecosyst., 51, 19-33.

CEAS/EFNCP. (2002): The environmental impact of dairy farming in the EU: Practical options for the improvement of the environmental impact. Fial report for European Commission (DGXI), p. 190, Submitted by CEAS Consultants (Wye) Ltd. and The European Forum for Nature Conservation and Pastoralism.

CIGR: Commission Internationale de Génie Rural. (1984): Report of working group on climatization of animal houses. Craibstone, Aberdeen: Scottish Farm Building Investigation Unit.

COM. (2006): Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy. N 508, accepted on: 15/09/2006.

ERICKSON G., KLOPFENSTEIN T., MILTON C. (2000): Dietary protein effects on nitrogen excretion and volatilization in opendirt feedlots. Proc. 8th Int. Symp. Animal, Agric. and Food Processing Wastes, p. 297-304, ASAE, St. Joseph, MI.

EUROPEAN COMMISION. (1991): Directive of the Council 12/12/1991 Concerning the Protection of Waters Against Pollution Caused by Nitrates from Agricultural Sources (91/676/EEC), Europ. Commision, Brussels, pp. 1–8.

EUROPEAN ENVIRONMENT AGENCY. (2013): Agriculture - greenhouse gas emission statistics, Accepted on: 28/10/2013.

FOER J. (2009): Eating Animals. New York: Little, Brown and Company, Kindle.

FREIBAUER, A. (2003): Regionalised inventory of biogenic greenhouse gas emissions from European agriculture. Eur. J. Agron., 19, 135-160.

GALLOWAY J., COWLIN E. (2002): Challenges and opportunities facing animal agriculture: optimising nitrogen management in the atmosphere and biosphere of the Earth. J. Anim. Sci., 80, 2, 157-167.

HAMERSCHLAG K., VENKAT K. (2011) A Meat Eater's Guide to Climate Change + Health: What You Eat Matters. Lifecycle Assesments: Methodology and Results, Environmental Working Group, Accepted on: 10/11/2011.

IPHARRAGUERRE I., CLARK J. (2005) Varying protein and starch in the diet of dairy cows. II. Effects on performance and nitrogen utilization for milk production. J. Dairy Sci., 88, 2556-2570.

IPCC – Intergovernmental Panel of Climate Change (2007): Working Group I Report "The Physical Science Basis"; Working Group II Report "Impacts, Adaptation and Vulnerability"; Working Group III Report "Mitigation of Climate Change"; (Fourth Assessment Report (AR4), available on: http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm.

JAMES T., MEYER D., ESPARZA E., DEPETERS E., PEREZ-MONTI H. (1999): Effects of dietary nitrogen manipulation on ammonia volatilization from manure from Holstein heifers. J. Dairy Sci., 82, 2430-2439.

JONKER J., KOHN R., HIGH J. (2002): Dairy herd management practices that impact nitrogen utilization efficiency. J. Dairy Sci., 85, 1218-1226.

HRISTOV, A., HUHTANEN P. (2008): Nitrogen efficiency in Holstein cows and dietary means to mitigate nitrogen losses from dairy operations. Proc., Cornell Nutr. Conf., Syracuse, NY, 21-23/10/2008, p. 125-136.

KETELAARS J., VAN DE VEN G. (1992): Stikstofstromen in agro-ecosystemen. In: Van der Meer H., Spiertz J. (Ed.) Agrobiologische thema's, p 33, CABO-DLO, Wageningen, Netherland.

KOHN R., DOU Z., FERGUSON J., BOSTON R. (1997): A sensitivity analysis of nitrogen losses from dairy farms. J. Environ. Manag., 50, 417-428.

KOZELOV L., YOSSIFOV M. (2013): Biofuel industry byproducts – alternative of traditional plant protein sources in ruminant' diets. Proc., Xth Int. Symp., Belgrade, Serbia, p. 504-520, available on: http://www.istocar.bg.ac.rs/ ISBN 978-86-82431-69-5.

KRASTEV K., PETROVA I. (2000): Influence of productive system and type of industrial buildings for dairy cows on ammonia concentration. Agricultural Science, 38, 3, 39-41.

MACKENZIE F. (1998): Our Changing Planet: An Introduction to Earth System Science and Global Environmental Change. 2nd ed., Upper Saddle River (NJ), Prentice-Hall.

MEADOWS D., MEADOWS D., RANDERS J. (1992): Beyond the Limits. Earthscan Publications Ltd., London.

MORGAN K., TROMBORG C. (2007): Sources of stress in captivity. Appl. Anim. Behav. Sci., 102, 262-302.

NISTC-National Institute of Standards and Technology Chemistry. (2014): WebBook, available on: http://webbook.nist.gov/chemistry.

NITRATES DIRECTIVE. (1991): Council directive concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC), Special edition in Bulgarian: Chapter 15 Vol. 002 P. 81 – 90.

OENEMA O., PIETRZAK S. (2002): Nutrient management in food production: Achieving agronomic and environmental targets. Ambio, 31, 159-168.

ROTZ C. (2004): Management to reduce nitrogen losses in animal production. J. Anim. Sci., 82, p.119-137.

SMIL V. (1999): Nitrogen in crop production: An account of global flows. Global Biogeochem., Cycles, 13, 647-662.

ST-PIERRE N., THRAEN C. (2001): Animal grouping strategies, sources of variation, and economic factors affecting nutrient balance on dairy farms. J. Dairy Sci., 77, 2, 72-83.

STEINFELD H., GERBER P., WASSENAAR T., CASTEL V., ROSALES M., DE HAAN C. (2006): Livestock's long shadow – environmental issues and options. Food and Agriculture Organization of the United Nations, ISBN 978-92-5-105571-7, Accepted on: 10/11/2011.

TAMMINGA S. (2003): Pollution due to nutrient losses and its control in European animal production. Livestock Production Sci., 84, 101-111.

VAN PASSEL S., NEVENS F., MATHIJS E., VAN HUYLENBROECK G. (2007): Measuring farm sustainability and explaining differences in sustainable efficiency. Ecol. Econ., 62, 149-161.

WWW.FAO.ORG (2006), available on: http://www.fao.org /newsroom/en/news/2006/1000448.

YOSSIFOV M., KOZELOV L. (2011): Estimation of corn dried distillers' grains with solubles (DDGSc) as protein source in small ruminant diets. Proc., ISC, Univ. Forestry, Sofia, Bulgaria, p. 49-59, available on: http://www.conference-fvm.org/archiv.

YOSSIFOV M., KOZELOV L. (2011a). Estimation of rapeseed meal as protein source in small ruminant diets. Proc., ISC, Univ. Forestry, Sofia, Bulgaria, p. 60-70, available on: http://www.conference-fvm.org/archiv.

YOSSIFOV M. (2012a): Influence of different protein supplements on sheep milk quantity and quality. Proc, XVth Int. Feed Tech. Symp., Novi Sad, Serbia, p. 392-403, available on: http://www.uns.ac.rs.

YOSSIFOV M., KOZELOV L. (2012): Effect of dried distillers' grains from wheat on lamb performance. Міжвідомчий тематичний науковий збірник №46, Kiev, Ukraine, p. 160-163, УДК 636.3.033.05.087.2.

YOSSIFOV M., KOZELOV L., DIMOV K. (2012): Effect of Dried distillers' grains with solubles from corn (DDGSc) fed on fattening Lambs. Agric. Sci. and Tech., 4, 3, 223-227.

YOSSIFOV M. (2013): Economic efficiency of early weaned feedlot lambs. Proc., part II, XXII ISC for young scientists, p. 35-38, Sofia, Bulgaria, ISSN 1314-4669.

YOSSIFOV M. (2013a): Effects of rapeseed meal as protein source in cereal-based diets on lamb performance. Xth Int. Symp., Belgrade, Serbia, p. 1022-1031, ISBN 978-86-82431-69-5, available on: http://www.istocar.bg.ac.rs.

YOSSIFOV M. (2013b): Efficacy of a probiotic feed additives on nitrogen balance in ruminant diets. Proc., Book of Abstracts, Final Feed for Health Conf., Milan, Italy, p.60, available on: http://www.feedforhealth.org/default.asp.

YOSSIFOV M. (2013c): Utilization by-products of biofuel industry in sheep diets, Ph.D. Thesis, Inst. Anim. Sci., Sofia, Bulgaria, available on: http://ias.bg/images/ PDF/Avtoreferat_Iosifov.pdf .

YOSSIFOV M., KOZELOV L. (2013): Effect of Rapeseed Meal (RSM) Fed on Fattening Lambs. VIth Int. Balkan Anim. Conf., Tekirdag, Turkey, p.176-186. available on: http://www.balnimalcon.nku.edu.tr/english.pdf.

YOSSIFOV M. (2014a): Effect of rapeseed meal as protein supplement in feedlot lamb diets on excretion of urinary purine derivates and microbial protein synthesis. Proc., Ist Int. Symp. on Anim. Sci., Belgrade, Serbia, p. 202-208, Accepted on: ISBN 978-86-7834-199-1.

YOSSIFOV M. (2014b): Establishment feeding value of wheat dried distillers' grains with solubles (DDGSw) as protein source in small ruminants' diets. Proc., ISC, Univ. Forestry, Sofia, Bulgaria, available on: http://www.conference-fvm.org/archiv.

YOSSIFOV M. (2014c): Correlations among kleiber ratio and performance at Lambs fed drylot diets supplemented with different protein sources. XXIIIth Int. Sci. Conf. for Young Scientists, Burgas, Bulgaria.

YOSSIFOV M. (2014d): Biological, ecological, sustainable and organic farming systems – comparison, opportunities, challanges and prospects. Vth Int. Sci. Agric. Symp., Jahorina, Bosnia and Herzegovina, pp. 644-653, available on: http://www.agrosym.rs.ba/archive/proceedings2014.

YOSSIFOV M. (2014e): Sustainable Food Production Chain for sustainable Ecosystems. Livestock, Climate Change and Food Security Conf., Madrid, Italy, p.120, available on: http://www.animalchange.wordpress.com/abstract-book.pdf.

Received 11 December 2014; accepted for publication 11 February 2015