KRMIVA

REDUCING THE ENVIRONMENT POLLUTION THROUGH MODIFICATION OF PERFORMED ANIMALS NUTRITION

SMANJENJE ZAGAĐENJA OKOLIŠA MODIFICIRANJEM HRANIDBE ŽIVOTINJA

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SUMMARY

Reduction of the nitrogen emmision to the environment can be achieved by the precisely balanced quantity of crude protein in relation to the norms of requirement, decreasing the protein level in the diets, adjusting the quantity of protein and ileal digested amino acids to the energy density in the feeds as well as by supplementation the poultry and swine diets with the pure amino acids to the optimal level, which can be approximated to the "ideal protein". Using the feed supplements, such as feed antimicrobes, enzymatic prepartations -particularly ß-glucanase, celullase, pentosanase and phytase, significantly decrease the excretion of nutrients in excrements, regulate the intestinal microorganisms population and improve feed utilization. The emission of main pollutants, wnich are derived from polygastric animals keeping: aggressive manure constituents, gaseous nitrogen ($N-NH_3$, $N-NO_2$), methane as product of bacterial fermentation of structural carbohydrates, unutilized minerals and other substances can be reduced through the application of precisely balanced diets. The excretion and environment loading with unutilized nutrients in intensive animal production should be constantly analysed.

INTRODUCTION

Intensive plant production causes a considerable loading of the environment as a result of using high doses of fertilizers and plant protecting substances. Processing plant constituents into high quality animal origin food-products is connected with the emission of unutilized metabolites to the environment. The elements from the liquidmanure and manure, mainly ammonia, nitrozoamines as well as nitrogenous organic and inorganic binds are transferred to the hydrosphere and litosphere (soils). Gaseous pollutants, such as ammonia, nitrous oxide, carbon dioxide and other are emitted to the atmosphere and they partially come back as constituents of acidrains and cause the rise of the risk of forest damage and are destroying the earth's highest sphere - ozone layer (the hole in the ozone layer over the Antarctic). The immense load for the atmosphere are the methane originating from the intestinal gases and from the organic matter degradation.

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Table 1. Average contents of the constituents in liquid-manure and in animals faeces (%) (data from different authors)

Tablica 1. Prosječan sadržaj sastojaka tekućeg gnoja i fecesa životinja (podaci raznih autora)

	Approximate concentration of nutrients - Približna koncentracija hranjivih tvari			
	SM (%)	N (kg/t)	P_2O_5 (kg/t)	K_2O (kg/t)
Cow liquidmanure - Tekući gnoj krava	24-27	6.0	3.5	8.0
Sow's liquidmanure - Tekući gnoj krmača	24-26	7.0	7.0	5.0
Hen's droppings - Feces kokoši	29-30	15.0	13.0	9.0
Broiler litter - Prostirka brojlera	57-62	29.0	25.0	18.0

The great concentration of animals in the industrial or specialist farms constitutes not only potential, but also realistic threat for the environment, mainly because of the nitrogenous binds, methane, unused phosphorus and many other mineral emissions by the animals (Table 1). This is the reason of introducing the environment friendly technologies in animal production and feeding systems with a view to minimalizing environment pollution by unutilized nutrients. Also, this is the problem that is now basic for wide and numerous scientific research.

The main sources of pollutants coming from animal production are: manure constituents, chemically and biologically aggressive liquidmanure, gaseous nitrogen ($N\text{-}NH_3$, $N\text{-}NO_2$), methane (CH_4), other metabolites of the nutrient degradation, excess of applied but unutilized minerals, silage leakage, biological active substances used in animal nutrition, medicinals, other chemical substances and pathogenic microbes excreted from the digestive tracts.

NITROGEN EXCRETION BY THE SWINE AND POULTRY

According to different investigations made by other authors 50-80% of global nitrogen amount, the widely, comes from agriculture (farming), and about 80 per cent of the yield from plant production is processed for the animal feeding purposes. The animal production is to high degree, responsible for nitrogen emission. A average about 10.5 kg of N that is annually excreted in to the environment goes to one pig fattening stall and about 28 kg goes to one stall of suckling sow with piglets.

The amount of the nitrogen emission from sow and poultry keeping depends on:

- quantity of feed protein given to the animals,
- digestibility of the nitrogenous substances,
- quantity of organic matter that can be fermented in digestive tract (dietary fibre),
- biological value of protein, amino acids composition of feed protein,
- productive performance and proportion of nitrogen used for covering the maintenance or productive requirements, that is to say on the intensity of the basic and productive metabolism,
- used feed additives that can improve the nutrients both their digestibility and utilization (enzymes and feed antibiotics, organic acids),
- nutrition systems (phasal feeding) and other factors.

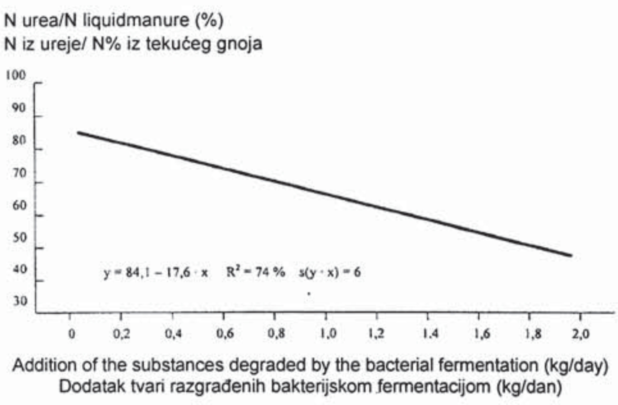
The protein content in the mixtures offered to animals or the amount of this nutrient in the diets are responsible for the amounts of nitrogen excreted in the urine and in the faeces. The proteins given to the animals in quantities exceeding their requirements may be metabolized, but the unutilized remains are transferred to excrements and to liquidmanure and are not stored in the organism. Quite essential is the proportion of nitrogen excreted in faeces or in urine to the total amount of excreted element. Mammals excrete a great amount of nitrogen in the faeces where about 80-90% is bound in organic connections, that are slowly mineralized. Nitrogen in mammal urine in over 50-70% from urea origin, in poultry excrements the main source of N is uric acid. These binds are quickly degraded to ammonia, which, in dependence on the pH of soil complexes, can be easily transferred to the atmosphere. This fast and mobile nitrogen from liquidmanure constitutes a particularly great threat for soil and ground water and can lead to the loss of cultivated plants.

The composition of the particular nitrogenous fractions in liquidmanure is closely dependent on quality and on biological value of the protein offered to the animals. By excessive protein intake, unutilized amino acids are amenable to degradation and are excreted as easily soluble substances in urea. Decreasing the amount of mobile nitrogen that origins from liquidrnanure is essential and relevant to ecology.

Low level of the polysaccharides in the sow diets favours the proliferation of the specific, saprophytic microflora and correct functions of gastrointestinal tract. In this way the amount of nitrogen in the faeces can be increased. (Figure 1) However, undue amount of NSP (non starch polysaccharides) decreases he digestibility of nutrients and their absorption from the intestine content. By the way of precisely balanced level of crude fibre it is possible to establish the proportions of nitrogen excreted as organic, slowly degraded ingredients of faeces or as easily utilized in soil nitrogenous components of urine.

Figure 1. Effect of addition of the substances degraded by the bacterial fermentation in swine on the share of N from urea in N of liquidmanure (adapted from Kirchgessner, 1994)

Slika 1. Djelovanje dodatka tvari razgrađenih bakterijskom fermentacijom u svinja na udio N iz ureje u N netekućeg gnoja (prema Kirchgessner, 1994.)

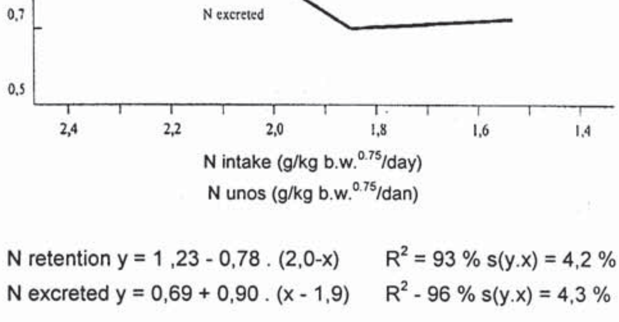


MINIMIZING OF NITROGEN EXCRETION

The basic criteria for protein balancing in the diets used in swine or poultry nutrition is coveringj the requirements for the essential amino acids, mainly for important, limited amino acids in rations for pigs - lysine, threonine, methionine, for poultry - methionine, threonine, lysine, tryptophan. Usually, other amino acids can be present in the mixtures or rations in amounts that exceed animal requirements. Lowering protein level and amount of the amino acids as well as adjusting their amounts to the animals requirements depending on the size and production phases or on the physiological status create great possibilities for obtaining the improvement of these nutrients utilization (Figure 2 and 3; Table 2). However, the basic problem, is the precise balancing of exogenous amino acids in the diet. This can be done by choosing proper feeds, such as high-lysine varieties of cereals or by supplementation of diets with pure amino acids.

Figure 2. Retention and excretion of nitrogen in swine on lowering N intake and constant exogeneous amino acid level (g/kg $bw^{0.75}$/day) (adapted from Roth et al., 1993)

Slika 2. Retencija i izlučivanje dušika, u svinja nakon smanjenja unosa N i stalne razine egzogenih amino kiselina (prema Roth i sur., 1993)



N retention y = 1 ,23 - 0,78 . (2,0-x) R^2 = 93 % s(y.x) = 4,2 %

N excreted y = 0,69 + 0,90 . (x - 1,9) R^2 - 96 % s(y.x) = 4,3 %

Figure 3. **Annual nitrogen excretion calculated per one fattening pig and number of fattening stalls and 80 kg N - from liquidmanure (fertilizer unit) with different protein levels in pig fattening (adapted from Kirchgessner et al., 1991)**

Slika 3. **Godišnje izlučivanje dušika izračunato po jednoj tovnoj svinji i broju tovnih pregradaka i 80 kg N - iz tekućeg gnoja (jedinica gnojiva) s različitim razinama bjelančevina u tovu svinja (prema Kirchgessner i sur., 1991.)**

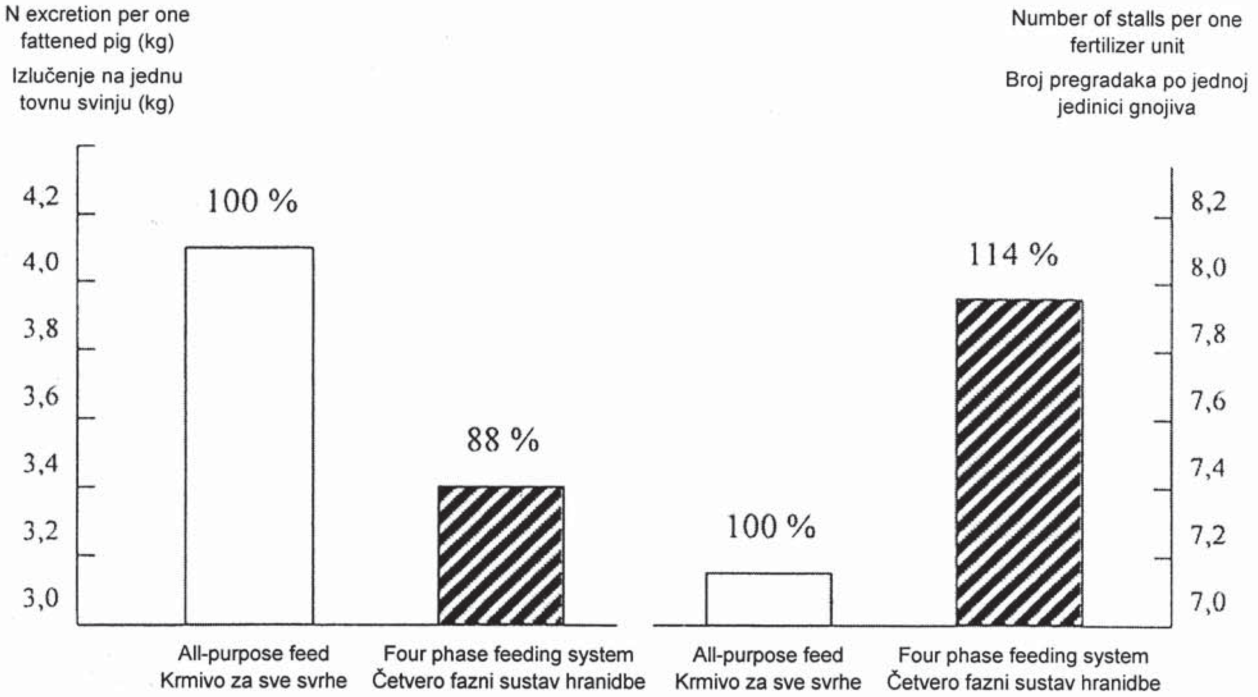


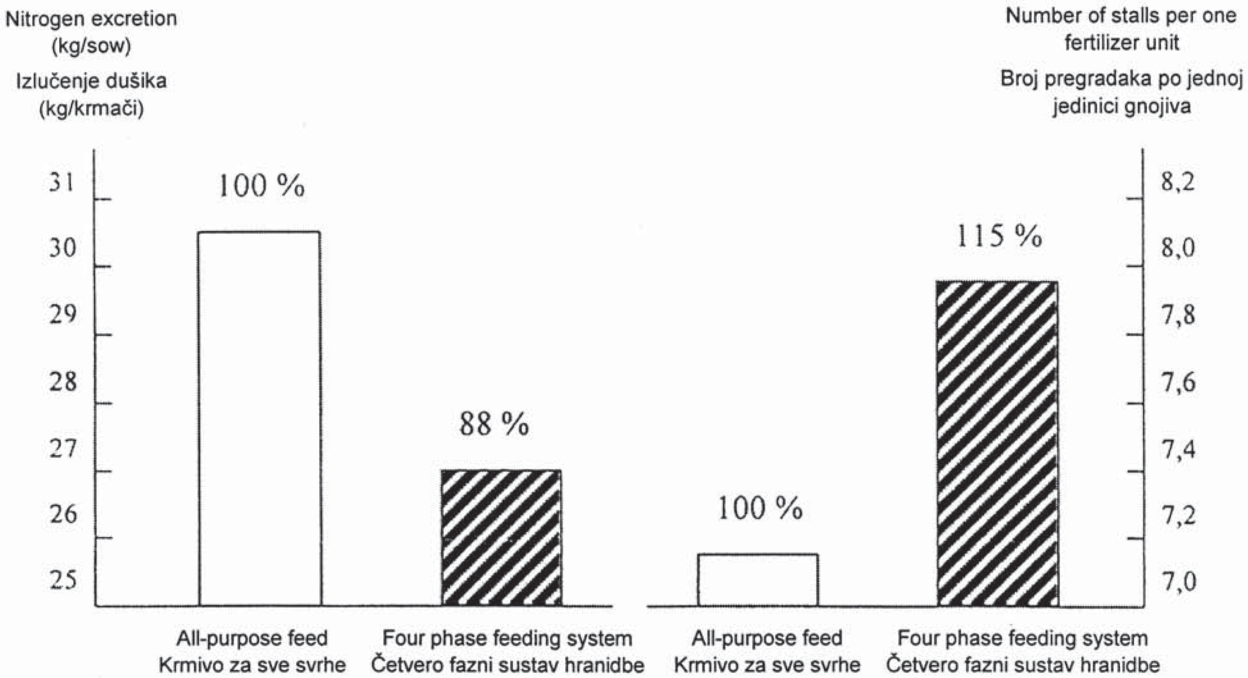
Table 2. **Nitrogen balance in swine in four phase feeding system (Gabel et al., 1993)**

Tablica 2. **Ravnoteža dušika u četiri-faznom sustavu tova (Gabel i sur., 1993.)**

Item	Four phases feeding system - Četvero fazni sustav hranidbe			
	20-25 kg	25-60 kg	60-85 kg	85-110 kg
Crude protein in mixture (g/kg) Sirove bjelančevine u smjesi	190	160	145	135
Feed intake (kg) - Unos hrane (kg)	9.46	87.0	75.0	92.8
N - intake (g) – Unos (g) N	288	2227	1747	2000
N - retention (g) - Retencija (g) N	147	998	638	578
N - excreted (g) - Izlučeno (g) N	141	1229	1109	1422
N - excreted per kg of weight gain (g) Izlučen N po kg porasta težine (g)	28.2	35.1	44.4	56.9
Body weight gain (kg) - Tjelesni porast težine	90			
N - excreted per kg of weight gain (g) Izlučen N po kg porasta težine (g)	43.3			

Figure 4. Annual nitrogen excretion in acount on one sow's stall and the number of stalls for sows in acount on 80 kg of nitrogen from liquid-manure (fertilizer unit) with using of different feeds for breeding sows (adapted from Kirchgessner and Roth, 1991)

Slika 4. Godišnje izlučivanje dušika po jednom pregratku za krmače i broj pregradaka za krmače na 80 kg dušika iz tekućeg gnoja (jedinica gnojiva) kod upotrebe različitih krmiva za rasplodne krmače (prema Kirchgessner i Roth, 1991.)



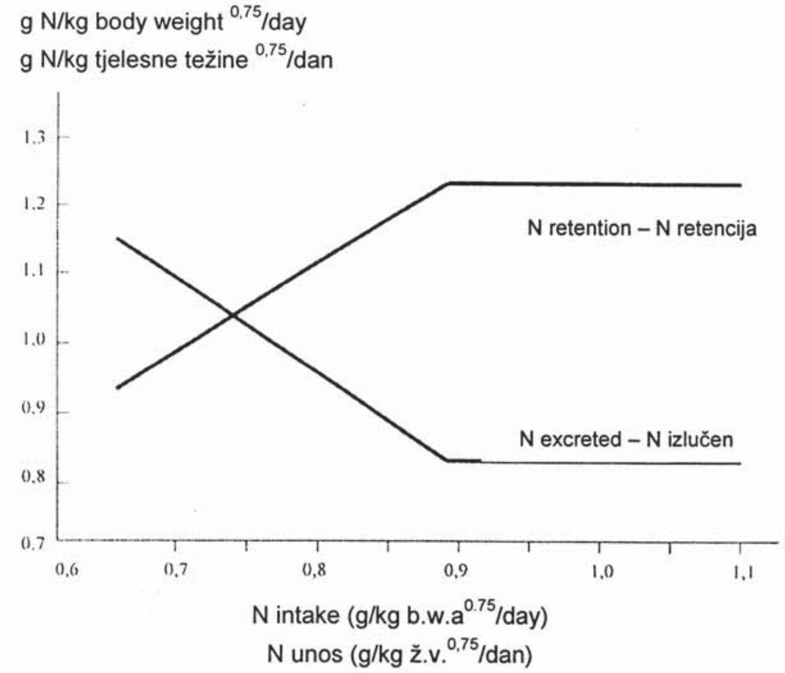
Great reduction in the crude protein concentration in animals diets can cause the appearance of exogenous amino acid defficiency. The synthesis of endogenous amino acids, such as proline, in organism, can also be insufficient. The quality of protein, possibly close to the "ideal protein" pattern, opens the chance for achieved profitable productive effects at the same time ensuring the best protein utilization and minimazing nitrogen emission into the environment. Minimal requirement for alpha-amine nitrogen from amino acids was evaluated by Kirchgessner and other authors on the level of 2 g/kg b.w^{0,75}. This value is the equivalent of about 13% of crude protein in the diets used in pig fattening.

One of the more effective methods of economical nitrogen management and decrease of its excretion is applying phasal feeding systems. They are adapted to the production processes or to the animal growth, enabling about 10-12% greater reduction of the nitrogen excretion and better productive use of the stalls by the average of 15% (Figure 4).

Great possibilities for improving nitrogen utilization by swine are applying diets supplementation with pure amino acids, especially with lysine (Figure 5) the first limited amino acid in pig feeding, as well as in the precisely balanced amounts of amino acids digested in the intestine in relation to the metabolizable energy content in feed. For example, addition of lysine into wheat-soya ration can decrease nitrogen excretion by 30-40%. On the basis of experimental data regarding maximal retention and minimal nitrogen excretion, the optimum of lysine content for fattening pig was estimated on the level of 0,77 g lysine per 1 MJ of the metabolizable energy.

Figure 5. **Nitrogen retention and excretion in swine caused by the increasing level of lysine intake and constant level of protein in the diet (g N/kg b.w.^{0,75}/day) (adapted from Markert et al, 1993)**

Slika 5. **Retencija dušika i izlučivanje u svinja prouzročeno povećanjem razine unosa lizina i stalnom razinom bjelančevina u obrocima (g N/kg ž.v.^{0,75}/dan) (prema Markert i sur., 1993.)**



N retention y = 1,24 - 1,25 . (0,91 -x) R^2 = 97 % s(y.x) = 2,1%

N excreted y = 0,82 + 1,25 . (0,91 -x) R^2 = 94 % s(y.x) = 4,4%

Decreasing the reserves for possible feeding mistakes that sometimes are made in practical nutrition, hydrothermical feed preparation, using feed additives, that can improve the nutrients digestibility, mainly the protein quality by reduced protein level are succesive ways of reducing nitrogen excretion to the environment.

In poultry nutrition the analogical methods are used for the improvement of nitrogen utilization from the feed mixtures. This beneficial effect may be achieved as a result of the reduction in protein level, supplementation of deficiencies with synthetic or pure amino acids, phasal feeding systems and also through the improvement of the degree of protein digestibility, applying microbiological supplements to the feeds etc. Significant are also species, age and the technological groups of poultry. In young broilers daily nitrogen intake amounts to 3.8-4.3 g, and its excretion 2.0-2.4 g. In ducks the nitrogen intake is higher (6.2-7.4 g) and the excretion amounts to 4.4-5.2 g. In young geese these values are: 8.5-9.7 g and 5.3-6.2 g/day/head, respectively. The average values are presented in table 3.

Table 3. **Utilization of the nitrogen and phosphorus in different species of poultry at age of 6-8 weeks of life (Jamroz et al., 1996b)**

Tablica 3. **Iskorištenje dušika i fosfora u raznih vrsta peradi u dobi od 6 do 8 tjedana života (Jamroz i sur., 1996b)**

Indicators - Pokazatelji	Chickens - Pilići	Ducks - Patke	Geese - Guske
Nitrogen - Dušik			
– intake (g/day/head) - unos (g dan/glava)	4.17	6.97	9.15
– retention (g/kg^{0,67}) - retencija (g/kg^{0,67})	1.45	1.43	1.64
– utilization (%) - iskorištenje (%)	46.01	31.97	37.00
Phosphorus - Fosfor			
– intake (mg/day/head) - unos (mg dan/glava)	774.1	1297.0	1697.3
– retention (mg/kg^{0,67}) - retencija (mg/kg^{0,67})	254.8	296.3	331.05
– utilization (%) - iskorištenje (%)	43.5	35.6	40.4

Table 4. Nitrogen excretion in faeces and its utilization in hens fed mixtures containing diversified crude protein level (Summers, 1993)

Tablica 4. Izlučivanje dušika fecesom i njegovo iskorištavanje u kokoši hranjenih smjesama raznih razina sirovih bjelančevina (Summers, 1993.)

Crude protein in mixture Sirove bjelanč. u smjesama	Nitrogen intake Unos dušika	Nitrogen N excretion Izluč. dušika	N excretion:egg weight ratio Izlučivanje N: omjer težine jajeta	
%	g/day/layer - g/dan/nesilice	g/day/layer - g/dan/nesilice	mg/g	%
19	3.73[a]	1.99[a]	45.8	100
17	3.40[a]	1.90[a]	40.2	88
15	3.01[b]	1.87[a]	41.2	90
13	2.84[b]	1.34[ab]	26.2	57
11	2.23[c]	1.10[bc]	22.9	50
9	1.68[d]	0.57[c]	21.2	46

Tablica 5. True amino acids digestibility in dependence on the crude protein level in feed (Huyghebaert et al., 1994)

Tablica 5. Prava probavljivost amino kiselina ovisno o razini sirovih bjelančevina u hrani (Huyghebaert i sur., 1994.)

Amino acids	Protein level in the feed (%) - Razina bjelanč. u hrani (%)	
Amino kiseline	24.2	20.5
Methionine	91	94
Methionine + Cystine	81	82
Lysine	89	89
Arginine	91	94
Threonine	86	86
Valine	84	90
Histidine	91	80
Leucine	92	92
Iso-leucine	85	91

Layer hen intake is about 2.4-4 g per day and it excretes 1.4-2.5 g, which taking the 365 days of year resulted in 511-911 g of pure nitrogen intake per bird (Preismann et al., 1991; Jamroz et al., 1994), however these parameters to a great degree on crude protein level in the concentrate mixtures as well as on the true amino acid digestibility (Tables 4 and 5) or used feed additives (Table 6).

Table 6. Nitrogen balance in young hens fed mixtures containing different protein level and supplemented with feed antibiotics (Jamroz et al, 1996)

Tablica 6. Izbalansiran dušik u mladih kokoši hranjenih smjesama različitih razina bjelančevina s dodatkom antibiotika (Jamroz i sur., 1996.)

Item	Kind of the experimental factor - Vrsta pokusnog faktora				
	Crude protein in mixtures (%) Sirove bjelanč. u smjesama(%)			Using of the feed antibiotics Upotreba antibiotika u hrani	
	13.4	14.5	16.1	Control (without antibiotics) - Kontrola (bez antibiotika)	+10ppm of feed antibiotics
N - intake (g/day/head) - Unos (g/dan/glava)	3.04[A]	3.24[A]	3.64[B]	3.26	3.36
N - excreted (g/day/head) - Izlučen (g/dan/glava)	1.46[a]	1.58[ab]	1.85[b]	1.67	1.59
N - retention (g/day/head) Retencija (g/dan/glava)	1.58	1.66	1.79	1.59	1.77
N - utilized (in % of nitrogen intake) Iskorištenje (u % unosa dušika)	52.0	51.2	49.2	48.8	52.7
N - egg weight (g/day/head) Jaje težina (g/dan/glava)	0.88	0.86	0.90	0.91	0.85
N - egg weight (in % of nitrogen intake) Jaje težina (u % unosa dušika)	29.2	26.6	24.8	28.2	25.5
N - excreted in excrements (in % of nitrogen intake) - Izlučen fecesom (u % unosa dušika)	48.0	48.8	50.8	51.2	47.3

a, b = $P<0,05$;A,B = $P<0,05$

NITROGEN EXCRETION IN COWS

Nitrogen excretion by cows is very high. Daily about 200-300 g of unutilized nitrogen is transferred to the liquidmanure. Per each kg of consumed dry matter the nitrogen excretion increases by 19-20 g on average. Nitrogen from bovine liquid manure is quickly degraded at about 40% of the total N. Increase of the protein level in cows diet leads to the more intensive degradation of this nutrient with relatively less variable microbial protein synthesis. Considering the specificity of the ruminal metabolism, the protein level of 13% in cow ration is recognized as the minimal dose that guarantees milk production on the level of about 15 ltr. In low milking cows the mentioned protein level can be too high and in high milking ones - too low.

The assortment of feeds that are used in cattle feeding, particularly in milking cows nutrition, to a high degree determines the amount of protein given to the animals. In cow fed on green forage, mainly in the grazing period, the overdosing of protein with simultaneous energy deficiency has been observed. This system of nutritition causes dynamic excretion of nitrogen. The basic strategy for decrease of the nitrogen emission is applying feeds containing high energy concentration and stimulation of the microbiological synthesis of the nitrogenous binds in the rumen.

The dairy cows fed the forages which are characterized by the lowered protein degradability such as maize, rape seed meal, palm or soy-bean meal can also minimize transfer of the unutilized nitrogenous binds to the urinal fraction of the liquidmanure.

Linear relationship between the nitrogen excretion and the amount of the milk yield level was confirmed experimentally (Figure 6). When the cows were fed a ration containing 15% of crude protein only, the increase of the milk yield from 10 up to 20 l decreased the amount of nitrogen transferred to the liquidmanure by about 22 g per 1 kg of milk. In animals that are characterized by high or very high productivity, usually less of the nutrients is consumed to cover the maintenance requirement and more for productive needs. This makes the metabolism of the nitrogenous binds more effective.

Figure 6. Liquidmanure quantity fall to one kg of milk (g/kg) in dependence on the milk yield (kg/day) and on the crude protein content in the ration (adapted from Kirschgessner et al., 1991)

Slika 6. Pad količine tekućeg gnoja na 1 kg mlijeka (g/kg) ovisno o prinosu mlijeka (g/dan) i sadržaju sirovih bjelančevina u obroku

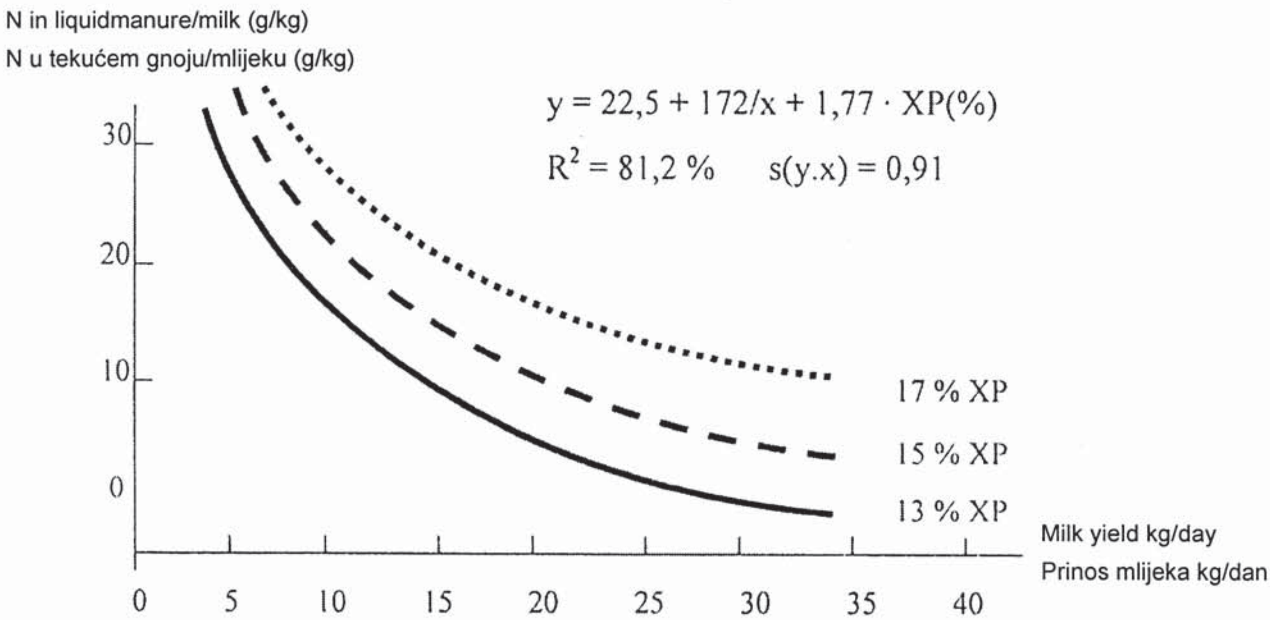
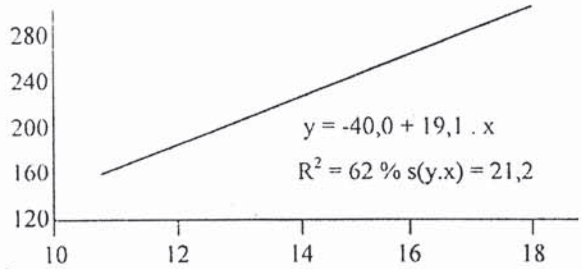


Figure 7. Daily N excretion to the liquidmanure by dairy cows, depending on the dry matter or nitrogen intake and daily milk yield (adapted from Kirchgessner et al., 1991)

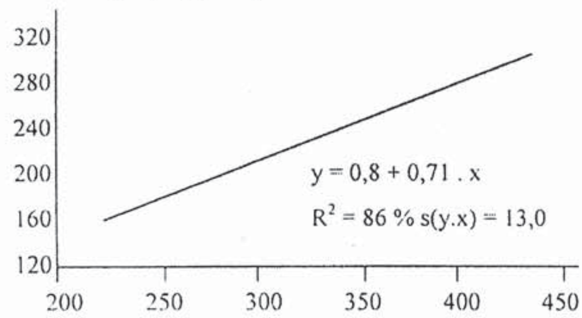
Slika 7. Dnevno izlučenje N mliječnih krava u tekući gnoj ovisno o unosu suhe tvari i dušika i dnevnom prinosu mlijeka (Kirchgessner i sur., 1991.)

N in liquidmanure (kg/day)
N u tekućem gnoju (kg/dan)



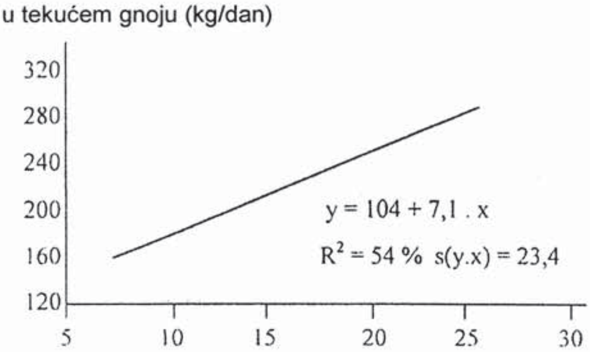
Feed intake (kg DM/day) - Unos hrane (kg ST/dan)

N in liquidmanure (kg/day)
N u tekućem gnoju (kg/dan)



Nitrogen intake (g/day) – Unos dušika (g/dan)

N in liquidmanure (kg/day)
N u tekućem gnoju (kg/dan)



Milk yield (kg/day) - Prinos mlijeka (kg/dan)

The biggest diversification of the nitrogen excretion in liquidmanure appears in cows producing about 4.000-6.000 kg of milk. On each 1% of the rise of the protein level in the ration, the increase of the nitrogen excretion in liquidmanure by 1.8 g per one kg of milk has been observed. These are very significant amounts. Proper protein dosing, reduction of protein intake as well as the increase of milk production,are optimal ways for the limitation of the environment loading by nitrogen coming from the diets given to the cows (Figure 7).

METHANE PRODUCTION

Methane concentration in the stratosphere as well as in the atmosphere systematically grows. This gas absorbs the infra-red rays and affects the intensity of the "greenhouse effect", significantly affecting the Earth's climate. Methane is one of the numerous causes of the ozone layer damage and the changes in the sun rays penetration.

Global methane emission is constantly increasing, at amount of 1 per cent per year already exceeding the 470-480 MT/year. This gas is produced mainly during the organic substances degradation processes and its basic source are water-logged and flooded areas on the surface of our planet. About 16% of the global amountof CH_4 comes from the animal production, the human activity (rubbish heaps, biomass burning and the energy carriers combustion) causing the production of ca. 48% of the total amount of methane.

In the group of farm livestock, ruminants produce about 96% of total CH_4 amount, monogastric animals only about 4 per cent of methane, which comes from animal production. As a result of microbial carbohydrates fermentation in the rumen or in caeca and colon of monogastric animals (swine) different amounts of CH_4 are created. Cattle produce about 100 to 400 g of methane per day and per head.

The amount of produced methane depends on the species and animals age, their performance, but mainly on the kind and amounts of nutrient and carbohydrate fractions that are present in the ration (Table 7). There is a direct link between the amount of dry matter and fibre intake and methane production.

Table 7. **Daily CH_4 emission in milking cows depending on nutrients intake (Kirchgessner et al., 1991)**

Tablica 7. **Dnevno ispuštanje CH_4 u mliječnih krava ovisno o unosu hranjivih tvari (Kirchgessner i sur., 1991.)**

From 1 kg of nutrients Iz 1 kg hranjivih tvari	Daily CH_4 emission Dnevno ispuštanje CH_4 (g)
Crude fibre - Sirova vlaknina	79
N-free extractives - NET	10
Crude protein - Sirove bjelanč.	26
Crude fat - Sirova mast	-212
Point of the intersection of the OX-axis by the regression curve - Točka presijecanja OX-osi krivuljom regresije	63

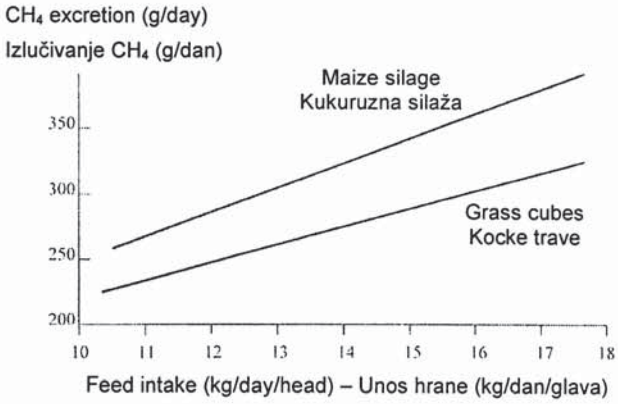
The ruminants are able to utilize feeds rich in cellulose and other structural polysaccharides. High share of cellulose stimulates the microflora proliferation but simultaneously increases the intensity of the methane production, where in the process of ruminai fermentation of simple sugars the biggest amount of propionic acid is synthetized, which is accompanied by proportionally low gas (also methane) production.

The dry matter of the ration given to the cows usually contains about 14-17% of crude fibre. This amount rises together with milk production. The high level of cellulose, and polysaccharides leads to the production of more than 60% of total CH_4, and the simple sugars are the substrates for the synthesis of about 30% of the pool of synthetized methane. In the feeding of low yielding cows traditionally great amounts of forages rich in polysaccharides are used, which unfortunately increases methane production (Figure 8). The amount of synthetized methane is modified by the body weight and the yield of milk produced in a limited degree, because the quantity of the celullose intake is restricted by the digestive tract capacity and by the body weight.

In the last parts of the digestion tract in monogastric animals, particularly in swine caeca the intensive fermentation of the celullose and non-starch polysaccharides (Figure 9) takes place. The sow can produce even up to 8 g and the fattened pig 1-6 g of methane daily while the man excretes less than I g of this gas per 24 hours. Formation of the CH_4 in the poultry caeca is very slight and is not important for the global methane production.

Figure 8. **Methane (CH_4) excretion by the lactating cows depending on the increase of feed intake and diversified kinds of feed in the ration (adapted from Kirchgessner et al., 1991c)**

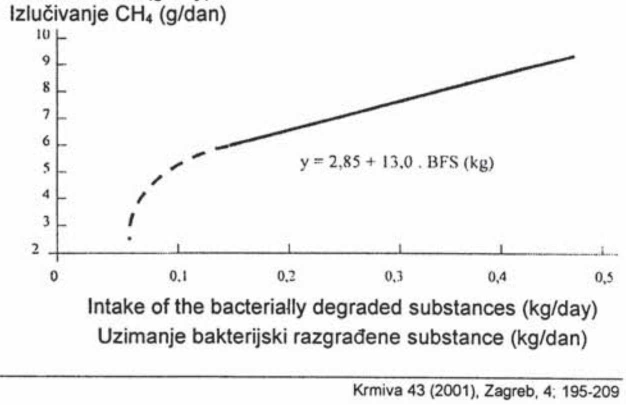
Slika 8. **Izlučivanje metana (CH_4) krava u laktaciji ovisno o povećanom unosu hrane i raznolikosti vrsta hrane u obroku (prema Kirchgessner i sur., 1991c)**



Basic feed - Temeljna hrana
- maize silage - kuk.silaža: $y = 93 + 16,8*x$
- grass cubes - kocke trave: $y = 81 + 14,0*x$

Figure 9. **CH_4 excretion in sows depending on intake of bacterially degraded substances (adapted from Kirchgessner et al., 1991)**

Slika 9. **Izlučivanje CH_4 u krmača ovisno o unosu bakterijski razgrađenih tvari (prema Kirchgessner i sur., 1991.)**

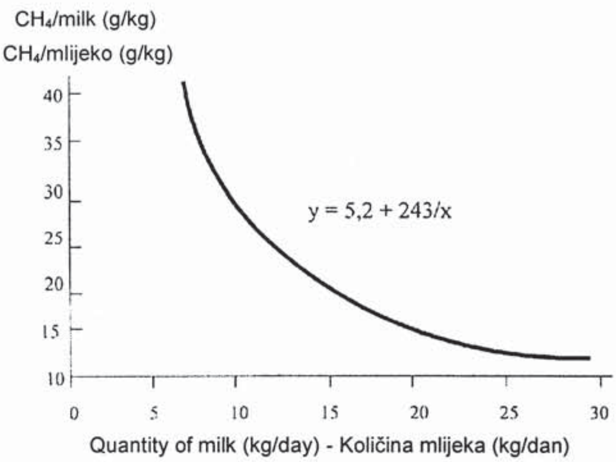


THE REDUCTION OF METHANE EMISSION INTO ENVIRONMENT

Increase of the animal yield significantly decreases the share of the basal metabolism for covering maintenance requiremens in total metabolism of nutrients. Increasing the cows productivity by about 10 liters of milk allows for reduction of methane production by about 30%. In low production, each additional liter of the secreted milk will result in considerable reduction in this gas emission (Figure 10).

Figure 10. CH_4 excretion calculated per kg of milk depending on the yield (adapted from Kirchgessner et al., 1991)

Slika 10. Izlučivanje CH_4 izračunato po kg mlijeka ovisno o prinosu (Kirchgessner i sur., 1991.)



The annual methane emission from the cow of the body weight about 500 kg and with the milk yield of 5.000 kg amounts about 100-115 kg. Beside the intensification of milk production or the increase of body weight gain in fattening cattle, the optimalization of the crude fibre content in the dry matter (the mean of 16%) and well established feed choice given to the animals, will make a contribution to real environment protection.

Feed additives, such as the ionophoric feed antibiotics can also modify the intensity and trend of ruminal fermentation to propionic acid synthesis, which is accompanied by reduced gaseous products concentration. It is deeply justifiable in the fattening animals feeding but in feeding lactating cows it can cause the decrease of the amount fat content in the milk. The prohibition of the application of feed antibiotics makes this way of environment protection from methane emission impossible.

The stored excrements - manure and liquidmanure as well as excrements that are left on the pastures also constitute important methane source. Emission of this gas from the tanks containing biomass can attain about 1/3 of total CH_4 which origins from the animal production. Enriching the liquidmanure with oxygen as well as using microbial preparations can significantly diminish the organic matter degradation and in the same way the methane production.

SOME ASPECTS OF ANIMAL WELL-BEING (manure gas poisoning)

Keeping animals, such as cattle or pigs, inside cowsheds or piggeries has resulted in both large production and concentration of manure in one place. Manure and liquidmanure are stored for long periods under the animals (pits under stall floor) or in special tanks. These environment circumstances (without oxygen - oxygen free) cause good conditions for the proliferation of fungi and anaerobic bacteria, which can degrade the organic and inorganic components of the manure and produce hydrogen sulphide, ammonia, methane and carbon dioxide as final products of their own metabolism.

Removing the manure or mixing the liquid-manure before emptying the tanks causes a release of large quantities of gases, which in many cases can be toxic for the animals, that are very often exposed to high concentrations of them, mainly H_2S which often causes acute poisoning. For example, peracute death can occur in cattle or pigs which are kept over the dung storage places when they are cleaned without good ventilation.

In cows, which have died from acute H_2S poisoning the pulmonary edema, hemorrhages into the muscle tissues and cerebral edema and necrosis changes are established. Chronic exposure to manure gases in low concentrations will cause a reduced productive performance in animals, however high concentrations of some gases, such as ammonia, will cause irritation of the upper part of the respiratory tract (sneezing, coughing) and will decrease the body, weight gain. Among the animals pigs are able to acclimatize to such these circumstances in a few days and after that no ill effects appear.

The production of toxic gases from manure can be inhibited by application of air or the use of some microbial or chemical preparations, which cause oxidizing reactions. The only good way for reduction of toxic gases concentration to non-toxic levels inside the animals houses is adequate ventilation while remowing manure or slurry.

PHOSPHORUS EXCRETION

Phosphorus constitutes a very important element of the food-chain, but the content of it in the litosphere does not exceed 1 per cent. This element is necessary during the photosynthesis process as well as in the energy transportation and in the nutrients synthesis in animal organism.

Large quantities of phosphorus stimulate the plants growth, and aquatic plants and plankton also cause intensified eutrophization of the surface water and even sea harbours. Phosphorus origins from different fields of human activity (communal liquid wastes), intensity of plant fertilization and from the unutilized binds which are excreted in excrements and transferred to the water in the soil. Annually is transfered to the hydrosphere not less than 18 kg of phosphorus per hectare.

The reduction of the excessive amount of phospshorus which is present in excrements is particularly difficult, because on the whole the degree of P utilization from the raw feeds is low. The amount of given phosphorus is processed into animal products at 10-30 %. The excess of the total phosphorus is excreted and constitutes the component of liquidmanure or slurry. For this reason the first, most effective way for reducing P emission is precise balancing of this mineral, ingredient and considering its availability, mainly for monogastric animals. In recent years the recommendations which characterize the animal needs for phosphorus have been radically reduced and the tables of feed values for the sake of the available phosphorus contents established. For cattle, the use of effective chemical binds rich in phosphorus is necessary.

The low P availability from cereals or leguminous seeds for poultry or swine can be corrected by using microbial, exogenous phytase. Introducing this enzyme to the mixtures may improve the P utilization from the phytic binds from 5 to 25% (Table 8).

Considerable profitable effects of the use of enzymatic preparations, which contain phytase, are observed in poultry fed large amounts of cereals. This is the justification of the economic purpose of using mixtures supplementation with the exogenous phytase, mainly in broiler feeding.

Table 8. Phosphorus absorption and the phytic binds degradation in the hens given microbial phytase (Van der Klis and Versteegh, 1991)

Tablica 8. Apsorpcija fosfora i razgradnja fitinskih spojeva u kokoši koje su dobivale mikrobnu fitazu (Van der Klis i Versteegh, 1991.)

Phosphorus level Razina fosfora g/kg	Phytase addition Dodatak fitaze FTU/kg	Phosphorus absorption Apsorpcija fosfora %	The degree of phytic binds degradation Stupanj rastvaranja fitinskih spojeva
3.5	-	22.5a	21.7a
3.5	250	49.7b	59.0b
3.5	500	51.8b	71.7c

a,b,c = $p<0,05$

REDUCTION OF MICROELEMENTS EXCRETION

In the last few years the worrying phenomenon of constant, often without good reason, increase of the doses of microelements as the compounds, which are characterized by pharmacological, antistressor or stimulating activity. Some minerals are accumulated in the animal tissues, for example - copper in the liver, lead and cadmium in kidneys, bones etc. Higher doses of these chemicals are introduced as the factors, which can activate the enzymes, fovourable to hemopoesis (Fe, Cu), demonstrate immunostimulatory or antidiarrhoea activity (Zn) or act as growth stimulating substances (Cu). Applied doses often exceed the real animal requirements. Particularly critical are considered the "pharmacological" doses of Cu and Zn given to pigs, which cause the transfer of the chemicals that can be toxic to other animals (copper for sheep) to the liquidmanure. Also, some recommendations of the selenium, chromium, nickel and other micro-elements application are not always scientifically confirmed. Still less is know about the degree of availability of trace elements and microelements from numerous inorganic bonds or chelates.

Table 9. Content of crude proteins and minerals in dry hens droppings (Jamroz et al., 1982)

Tablica 9. Sadržaj sirovih bjelančevina i minerala u suhom fecesu kokoši (Jamroz i sur., 1982)

Item		Content - Sadržaj
Crude protein Sirove bjelančevine	(%)	27.0 - 29.6
Ca	g/kg	47.2 - 56.2
P		10.6-11.0
K		12.5 - 20.0
Na		3.8-4.3
Mg		1.9-4.4
Fe	mg/kg	800 - 920
Mn		300 - 445
Zn		500 - 800
Cu		13-15
Pb		1.85-3.30
Cd		1.51-3.92
Hg		0.022 - 0.074
As		0.040 - 0.042

Controversies also arise from the high level of copper, cobalt and iodine in some premixes which are used mainly in turkey feeding as the form of preventing aorta wall spliting. Specialists in the field of poultry nutrition report on the excess of the requirements for microelements and vitamins in animal feeding. These, biologically active substances may also create a serious environment load (Table 9). More knowledge on the above subjects can make real ecological activity in this field possible.

OTHER NUTRITIONAL ASPECTS OF THE ENVIRONMENT PROTECTION

In past years the regulations concerning the registration of the feed additives, mainly microbial origin preparations, are going to be very rigorous. The necessity for the presentation of experiemental results on the activity of biological substances or their metabolites, excreted from the intestinal tract as well as monitoring plants and population small animals and microorganisms in the soil is now recognized as very important.

Biological activity of the silage leakage and the waste from milk or meat industry etc., transferred to the ground water in the agricultural areas can significantly affect the pH value of soil, its microbial stability and other aspects of the lito- and hydrosphere functions.

In the light of above presented elements of animal nutrition it is evident that through the precisely balanced minerals in the mixtures or rations, according to the true requirement, through the correct feed choice for different species and productive groups of animals, through the use of different feed additives as well as numerous ways of components and feeds preparation it is possible to improve feed utilization and reduce unutilized nutrients emission.

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SAŽETAK

Smanjenje ispuštanja dušika u okoliš može se postići pravilnim balansiranjem količine sirovih bjelančevina u odnosu na norme potreba, smanjenjem razine bjelančevina u obrocima, prilagođavanjem količine bjelančevina i amino kiselina probavljenih u ileumu na gustoću energije u hrani kao i dodavanjem najboljih količina čistih amino kiselina u obroke peradi i svinja, što može biti približno "idealnim bjelančevinama". Upotreba krmnih dodataka kao što su krmni antimikrobi, enzimatski pripravci - naročito β--glukanaza, celulaza, pentosanaza i fitaza znatno smanjuje izlučivanje hranjivih tvari u fecesu, regulira populaciju crijevnih mikroorganizama i poboljšava iskorištenje hrane. Ispuštanje glavnih zagađivača što nastaju u uzgajanju višeželučanih životinja: agresivni sastojci gnoja, plinoviti dušik ($N\text{-}NH_3$, $N\text{-}NO_2$), metan kao proizvod bakterijske fermentacije strukturnih ugljikohidrata, neiskorišteni minerali i druge tvari mogu se smanjiti primjenom ispravno izbalansiranih obroka. Izlučivanje i opterećenje okoliša neiskorištenim hranjivim tvarima u intenzivnoj proizvodnji životinja treba neprekidno analizirati.