

ISBN: 978-953-6135-93-6

Published by: Faculty of agriculture, University of Zagreb,
Zagreb, 2011

Main editor: Miroslav Kapš

Prepared by: Dragica Šalamon

Supported by: Ministry of science, education and sports of
Republic of Croatia

19th ASD Organizing Committee

president:

Ino Čurik

secretary:

Dragica Šalamon

members:

Vlatka Čubrić Čurik

Maja Ferenčaković

Ivan Jurić

Antun Kostelić

Branko Liker

Mirjana Mihelčić

Vlatko Rupić

Bruna Tariba

associated members:

Davor Romić,

Dean of Faculty of Agriculture, University of Zagreb

Igor Štoković,

EAAP workgroup president for Central and Eastern Europe

scientific committee coordinator and the main editor:

Miroslav Kapš

members of the scientific committee and the editorial board:

Alen Džidić

Marija Đikić

Danijel Karolyi

Krešimir Salajpal

Co-ordination Committee

Ino Čurik, Croatia
Marija Đikić, Croatia
Gordana Kralik, Croatia
Antun Petričević, Croatia
Melinda Kovács, Hungary
Gábor Milisits, Hungary
Csaba Szabó, Hungary
Martino Cassandro, Italy
Gulio Cozzi, Italy
Enrico Sturaro, Italy
Marko Čepon, Slovenia
Dragomir Kompan, Slovenia
Silvester Žgur, Slovenia

Universities of the Quadrilateral Agreement

University of Zagreb, Faculty of Agriculture, Department of
Animal Science, Zagreb

University of J. J. Strossmayer, Faculty of Agriculture, Osijek,
Croatia

Kaposvár University, Faculty of Animal Science, Kaposvár,
Hungary

University of Padova, Department of Animal Science, Padova,
Italy

University of Ljubljana, Biotechnical Faculty, Zootechnical
Department, Domžale, Slovenia

Patrons of the 19th ASD



MINISTRY OF SCIENCE, EDUCATION AND SPORTS
OF THE REPUBLIC OF CROATIA



MINISTRY OF AGRICULTURE, FISHERIES
AND RURAL DEVELOPMENT OF THE
REPUBLIC OF CROATIA



EUROPEAN FEDERATION
OF ANIMAL SCIENCE

Sponsors



MINISTRY OF SCIENCE, EDUCATION AND SPORTS
OF THE REPUBLIC OF CROATIA



Croatian Academy of Sciences and Art



National Park Krka



Triglav insurance

Donations



Croatian Agriculture Agency



Croatian Hunters Association



Gorea plus d.o.o.

Program

WEDNESDAY, 21st of September 2011

8.00 Registrations

9.30 - 10.15 Symposium opening

10.15 - 11.00 *Welcome drink*

PLENARY LECTURES: (*Chair: Ino Čurik*)

11.00 – 11.20 **Quadrilateral collaborations in the field of animal science - outcome and future prospects** Melinda Kovács, Csaba Szabó, Gábor Milisits Jozsef Stefler

11.20 – 11.40 **Collaborations in the Field of Education at University Level** Martino Cassandro

11.40 – 12.00 **Animal production as a perspective for Quadrilateral collaboration** Krešimir Salajpal, Danijel Karolyi

12.00 – 12.20 **Collaboration in the field of conservation of Animal Genetic Resources** Drago Kompan, Marko Čepon, Silvio Žgur

12.20 - 14.00 *Lunch break*

14.00 – 15.00 **PRODUCTION SYSTEMS: MANAGEMENT AND HEALTH** (*Chairs: G. Cozzi, A. Kostelić*)

15.00 – 16.00 **ANIMAL NUTRITION** (*Chairs: C. Szabó, K. Salajpal*)

16.00 – 16.30 *Coffee break and posters*

16.30 – 17.45 **ANIMAL PRODUCT QUALITY** (*Chairs: S. Žgur, M. Čandek Potokar, D. Karolyi*)

18.00 *Coordination committee meeting*

Program

THURSDAY 22nd of September 2011

INVITED LECTURES: (*Chair: Ino Čurik*)

9.00 - 9.30 **Genomic Selection: promise - experience – expectation** Johann Sölkner

9.30 - 10.00 **Genes in the landscape: Potential & pitfalls of statistical methods in spatial genetics** Alain Frantz

10.00 - 10.30 *Coffee break and posters*

10.30 - 12.00 **BREEDING AND GENETICS I** (*Chairs: I. Nagy, B. Fuerst-Waltl*)

12:00 - 13:30 *Lunch break*

13.30 – 14.30 **BREEDING AND GENETICS II** (*Chairs: R. Finocchiaro, V. Čubrić Čurik*)

14:30 - 15:30 **BREEDING AND GENETICS – III**
(*Chairs: G. Mészáros, Š. Malovrh*)

15:30 - 16:00 *Coffee break and posters*

16:00 - 17:00 **BREEDING AND GENETICS –IV** (*Chairs: G. Gorjanc, A. Cecchinato*)

17:00 - 18:00 Final poster section and the selection of the best poster (*Chair:*) ***Please remove your posters before the trip to Jurlinovi dvori!***

18:30 *Dinner at Jurlinovi dvori*

FRIDAY 23rd of September 2011

9.00 **field trip NP Krka**

Table of Contents

1. PRODUCTION SYSTEMS: MANAGEMENT AND HEALTH

Wednesday 14.00 - 15.00.....pages 1-13

1.1. ORAL PRESENTATIONS

Effect of immunocastration on performance of Slovenian pig fatteners, *Martin ŠKRLEP et al.*at 14.00.....page 2

Prevalence of locomotory system disorders in veal calves and risk factors for occurrence of bursitis, *Marta BRSCIC et al.*at 14.12.....page 3

The effect of prestimulation on milking characteristics in Simmental, Holstein-Friesian and Brown Swiss cow breed, *Dragica SALAMON et al.* at 14.24.....page 4

Growth and mortality of suckling rabbits, *Martina PLANINC et al.* at 14.36.....page 5

Preliminary results on the effect of chronic T-2 toxin exposure in rabbit bucks, *Gábor TORNÝOS et al.* at 14.48.....page 6

1.2. POSTERS

Influence of infection with Caprine Arthritis Encephalitis Virus on milk production of French Alpine goats in Croatia, *B. Tariba* et al.*8

Differences in carcass and meat quality between organically reared cocks and capons, *M. Volk et al.*9

Physiological and behavioural responses in piglets submitted to castration: preliminary study, *C. Lonardi* et al.*10

Changes of some parameters of dairy cows teat during machine milking, M. Stojnović*, D. Alagić.....11

Non invasive (CT) investigation of the lung in *Bordetella bronchiseptica* infected pigs, R. Pósa* et al.12

Effect of simulated transport vibration on egg hatchability efficiency, F. Shahbazi* et al.13

2. ANIMAL NUTRITION

Wednesday 15.00 - 16.00.....pages 14 - 23

2.1. ORAL PRESENTATIONS

Effect of linseed supplementation on carcass, meat quality and fatty acid composition in pigs, Matjaž ČERVEK et al.at 15.00.....page 15

The effect of coenzyme Q10 and lipoic acid added to the feed of hens on physical characteristics of eggs, Dušan TERČIČ et al.at 15.12.....page 16

Late gestational undernutrition alters plasma IGF-1 concentration during subsequent lactation in ewe, Ali KIANI et al.at 15.24.....page 17

A comparison among analytical methods to assess fatty acids and conjugated linoleic acids (CLA) content and repeatability of ruminant faeces, Giacomo CESARO* et al.at 15.36.....page 18

Cellular immune response of weaned pigs fed diet supplemented with an essential oil, Veronika. HALAS* et al. ...at 15.48.....page 19

2.2. POSTERS

Habitat use and activity of roe deer (*Capreolus capreolus* L.) in Eastern Croatia, D. Degmečić et al.21

Influence of different levels of phytase enzyme on Japanese quail (*Coturnix japonica*) performance, Nasrollah Vali*, M. A. Jalali22

Impact of nanosil diets on growth performance in broilers, S. Mohammadzadeh et al.23

3. ANIMAL PRODUCT QUALITY

Wednesday 16.30 - 17.45.....pages 24 – 39

3.1. ORAL PRESENTATIONS

Consumers' attitudes towards farm animal welfare and their influence on meat consumption, Marija CERJAK et al.at 16.30.....page 25

Carcass quality of slaughtered Cika and Brown cattle in Slovenia, Mojca SIMČIČ et al.at 16.42.....page 26

Carcass classification measurements in pigs as affected by the operator and abattoir, Maja PREVOLNIK et al. at 16.54.....page 27

Growth rate, slaughter traits and meat quality of lambs of three Alpine sheep breeds Erika PELLATTIERO et al. at 17.06.....page 28

Application of infrared spectroscopy in honey analysis, Lidija SVEČNJAK et al.at 17.18.....page 29

Effects of added boar taint substances (skatole and androstenone) on the sensory quality of pork, Agnes KIRSCHING et al.at 17.30.....page 30

3.2. POSTERS

Monitoring of physicochemical changes in frozen fish muscle tissue, František Ježek*, H. Buchtová.....	32
The effect of the abattoir on beef carcass classification results, Maja Prevolnik* et al.	33
The influence of zinc in nutrition on meat quality of young goats, Alena Saláková* et al.	34
Fattening ability, carcass and meat quality of heavy Tsigai lambs, Peter Polak* et al.	35
Variation in nitrogen components of sheep milk in Dalmatian hinterland, S. Matutinovic et al.	36
The effect of omega-3 fatty acid enrichment on the quality characteristics of a special Hungarian cold-cut (Párizsi), Judit Belovai* et al.	37
Effect of Belgian Blue and Piedmontese sires on carcass and meat quality traits of crossbreed heifers, Ilario Bazzoli* et al.	38
Weight loss in the processing of dry-cured mutton: Effect of age, gender and processing technology, Marina Kravica* et al.	39

4. BREEDING AND GENETICS.....40 - 75

4.1. ORAL PRESENTATIONS I

Thursday 10.30 - 12.00.....pages 40 – 47

Exploring different model structures for the genetic evaluation of dairy bull fertility, Francesco TIEZZI et al.at 10.30.....page 41

Table of Contents

Estimation of variance components for litter size in the first and later parities in Improved Jezersko-Solcava sheep, Dubravko ŠKORPUT et al.at 10.42.....page 42

Lambing interval in Jezersko-Solčava and Improved Jezersko-Solčava breed, Andreja KOMPREJ et al.at 10.54.....page 43

Genetic and phenotypic parameters for reproduction traits of Landrace sows in Latvia, I. Ziedina et al.at 11.06.....page 44

Morphometrical analysis of reproduction traits for the wild boar (*Sus scrofa* L.) in Croatia, Nikica ŠPREM, et al. at 11.18.....page 45

Milk yield traits, somatic cell score, milking time and age at calving of pure Holstein versus crossbred cows, Francesca MALCHIODI et al.at 11.30.....page 46

New research strategies in lactation biology, Jernej OGOREVC et al.at 11.42.....page 47

4.2. ORAL PRESENTATIONS II

Thursday 13.30 - 14.30.....pages 48 – 52

Partitioning of genetic trends by origin in Croatian Simmental cattle, Marija ŠPEHAR et al.at 13.30.....page 48

Genetic parameters and inbreeding depression of litter weight in Pannon White rabbits, István NAGY et al.at 13.42.....page 49

Inbreeding and its effect on performance traits in Austrian meat sheep, Lina MAXIMINI et al.at 13.54.....page 50

Mitochondrial DNA diversity in wild boars from the Istria and Cres Island, Vlatka CUBRIC CURIK et al.at 14.06.....page 51

Use of mitochondrial DNA analyses in verification of the Lipizzan horse pedigree, Mato ČAČIĆ et al.at 14.18.....page 52

4.3. ORAL PRESENTATIONS III

Thursday 14.30 - 15.30.....pages 53 – 57

Analysis of the relationships between type traits and longevity in Croatian Simmental cattle using survival analysis, Nikola RAGUŽ, S. Jovanovac.....at 14.30.....page 53

Genetic parameters of growth traits from a joint evaluation of purebred and crossbred pigs, Henrietta Nagyné KISZLINGER et al.at 14.42.....page 54

Economic importance of the traits for Slovak Pinzgau breed reared in dairy and cow-calf system, Emil KRUPA, et al.at 14.54.....page 55

Genetic parameters of conformation traits in Brown, Simmental and Holstein breed calves in Slovenia, Betka LOGAR et al.at 15.06.....page 56

Improving the final liveweight and growing ability of TETRA-H a dual purpose chicken type by using a new experimental Sire line, Anita ALMASI et al.at 15.18.....page 57

4.4. ORAL PRESENTATIONS IV

Thursday 16.00 - 17.00.....pages 58 – 62

Cluster analysis on across country genetic correlations for conformation traits in Holstein cattle breed, Mara BATTAGIN et al.at 16.00.....page 58

Runs of homozygosity reveal genome-wide autozygosity in the Austrian Fleckvieh cattle, Maja FERENCAKOVIC et al.at 16.12.....page 59

How to use less markers in admixture studies?, Anamarija FRKONJA* et al.at 16.24.....page 60

Effects of stearoyl-CoA desaturase 1 and sterol regulatory element binding protein gene polymorphisms on milk production, composition and coagulation properties of individual milk of Brown Swiss cows, *Alice MAURMAYR et al.*at 16.36.....page 61

Use of SNP markers within the fat mass and obesity-associated (FTO) gene to verify pedigrees and determine haplotypes in paternal half-sib families of Slovenian Simmental cattle, *Daša JEVŠINEK et al.*at 16.48.....page 62

4.5. POSTERS

The effect of myogenic factor 5 polymorphism on the meat quality in Chinese *Bos taurus*, *J. A. Ujan* et al.*64

Pedigree analysis of Slovak Pinzgau breed, *Ondrej Kadlečík* et al.*65

Phenotypic relationships between longevity and udder conformation traits in three Hungarian Holstein-Friesian herds, *Szilvia Szögi* et al.*66

The T945M single nucleotide polymorphism of the bovine leptin receptor gene in population of Slovak spotted bulls, *Ana Trakovická et al.*67

Relationship between production and reproduction traits dairy cows of Slovak spotted breed, *Jozef Bujko* et al.*68

Estimation of Genetic parameters for milk urea and milk production traits of Latvian Brown cows, *Daina Jonkus* et al.* ..69

Genotype of melatonin receptor MT1 (MTNR1A) and puberty in Mediterranean Italian buffalo, *Marta Paludo* et al.*70

Polymorphism of caprine SLC11A1 gene and relationships with hygienic characteristics of milk, *Gianpiera Piras* et al.*71

Geographic Information Systems (GIS) for Livestock Science: applications and case studies, Enrico Sturaro* et al.72

Production and behavioural traits of honeybee queens from Croatian breeding program, Marica Maja Dražić* et al.73

Analysis of conformation traits in Slovenian Posavje horse, Klemen Potočnik*, M. Mesarič74

Crossbreeding Effects of Lori Black Goat × Saanen on the some Growth & Milk Traits in Qom Province, Seyed Mehdi Hosseini Ghomi* et al.75

5. PLENARY LECTURES

Wednesday 11.00 - 12.20.....pages 76 - 128

Quadrilateral collaborations in the field of animal science – outcome and future prospects, Gábor MILISITS, Csaba SZABÓ, Melinda KOVÁCS, József STEFLER..... at 11.00.....page 77

Collaborations in the Field of Education at University Level Martino CASSANDRO..... at 11.20.....page 89

Animal production as a perspective for Quadrilateral collaboration, Krešimir SALAJPAL, Danijel KAROLYI.....at 11.40.....page 109

Collaboration in the field of conservation of Animal Genetic Resources Drago KOMPAN, Marko ČEPON, Silvio ŽGUR..... at 12.00.....page 129

1. PRODUCTION SYSTEMS: MANAGEMENT AND HEALTH

Chairs: G. Cozzi, A. Kostelić

1.1. ORAL PRESENTATIONS

EFFECT OF IMMUNOCASTRATION ON PERFORMANCE OF SLOVENIAN PIG FATTENERS

Martin ŠKRLEP*¹, Nina BATOREK¹, Blaž ŠEGULA¹, Marta ZAJEC², Stane KOŠOROK², Marija GLAVAC-VNUK³, Valentina KUBALE-DVOJMOČ⁴, Gregor FAZARINC⁴, Marjeta ČANDEK-POTOKAR^{1,5}

¹ Agricultural institute of Slovenia, Ljubljana; ² Ihan Farms d.d., Domžale; ³ Panvita, pig farm Nemščak d.o.o., Beltinci; ⁴ Veterinary Faculty, University of Ljubljana; ⁵ Maribor University, Faculty of agriculture and life sciences, Hoče

Corresponding author: **Martin ŠKRLEP**, +38612805234; +38612805255; martin.skrlep@kis.si

The influence of the immunocastration (immunisation against GnRH) on pig performance (growth, carcass and meat quality traits) was investigated in two parallel experiments (on two farms) with two crossbreeds – G1 (50% Duroc) and G2 (50% Pietrain). Within the crossbreed, the pigs were assigned to three experimental groups; entire males (EM, n=49), immunocastrates (IC, n=45) and surgical castrates (SC, n=45). Those assigned to IC group were vaccinated at the age of 12 and 19 weeks. Pigs were individually housed, their feed intake (*ad libitum*) and weight (at 12, 19 and 24 weeks) were recorded. At the age of 24 weeks, the pigs were slaughtered and their carcass and meat quality traits were assessed. We hypothesized that treatment response could have been different in two crossbreeds. However the interaction was insignificant, thus the treatment effect is presented on pooled results for both crossbreeds. Until the revaccination, IC were similar to EM pigs, thereafter they exhibited an increase in feed intake and growth rate. Overall, they presented an advantage in growth rate and feed efficiency as compared to SC. They also exhibited better carcass properties as SC without any major effect on meat quality. The present study provides the initial information on the immunocastration effect in Slovenian herds that should further be supported by testing it in usual rearing conditions and group housing.

Key words: pig, immunocastration, growth performance, carcass properties, meat quality

PREVALENCE OF LOCOMOTORY SYSTEM DISORDERS IN VEAL CALVES AND RISK FACTORS FOR OCCURRENCE OF BURSITIS

Marta BRSCIC*¹, Flaviana GOTTARDO¹, H el ene LERUSTE², B.
Joop LENSINK², Kees C.G. VAN REENEN³, Giulio COZZI¹

¹ Dipartimento di Scienze Animali, Universit  degli Studi di Padova; ² Groupe ISA, Lille Cedex; ³ Livestock Research, Wageningen

Corresponding author: **Marta BRŠ IC**, +39049 8272620; +390498272669;
marta.brscic@unipd.it

The study aimed to assess the prevalence of locomotory system disorders within a wide cross-sectional study in 174 veal calves farms and to investigate risk factors associated to disorders with a relevant prevalence (>1%). A representative sample of the European veal production systems was considered in the three major producing countries (100 in NL, 50 in FR, 24 in IT). One batch/farm was observed in three stages of the fattening. At each visit calves with evidence of bursitis, hoof lesions, joint lesions, and lameness were recorded. A set of production system descriptors gathered by an interview to the farmer were considered as potential risks. Results showed an average prevalence $\leq 1\%$ of calves for hoof and joint lesions, and lameness at any stage. Bursitis was observed on 0.2%, 4.1% and 11.2% of calves at 3, 13 wks and at the end of fattening, respectively. Risk factors for bursitis were linked to concrete and wooden slatted floors, to space allowance ≤ 1.8 m²/calf, and floors aged <8 years while type of housing system (small vs. large groups) was not relevant. There was a significant interaction between stage of fattening and type of floor on bursitis. At the early stage, slatted and bedded floor were similar while at the end of the fattening the highest least mean was observed for calves on concrete floors. Bedding materials had a preventive effect. Rubber or straw should be largely adopted for veal calves as alternative solutions to hard floors in order to improve animals' comfort, locomotory system health and welfare status.

Key words: veal calf, locomotory disorders, welfare, bursitis, risk factors

THE EFFECT OF PRESTIMULATION ON MILKING CHARACTERISTICS IN SIMMENTAL, HOLSTEIN-FRIESIAN AND BROWN SWISS COW BREED

Dragica SALAMON¹, Igor MATOKOVIC¹, Vinko BATINIC², Alen DZIDIC*¹

¹ *Department of Animal Science, Faculty of Agriculture, University of Zagreb;* ² *Faculty of Agriculture and Food Technology, University of Mostar*

Corresponding author: Alen DŽIDIĆ, +38512393633; +3852393947; adzidic@agr.hr

The objective of this study was to determine the differences in milking characteristics between Simmental, Holstein-Friesian and Brown Swiss cow breed, when 0, 30 or 60 s of prestimulation was applied. The experiment was conducted on the commercial farm Kovažik, where 12 cows (four cows per breed) were randomly assigned to three prestimulation treatments. Each treatment was performed during two days and followed by a one day of rest. Milking characteristics (main milking phase duration, milking time, milk yield, peak flow rate and average flow rate) were measured. Additionally, bimodality of milk flow curves was evaluated. The results of this experiment show that the highest number of bimodal curves was observed in the treatment without prestimulation. Prestimulation duration did not influence observed milking characteristics. However, treatment without prestimulation had numerically the largest number of bimodal curves, longest duration of main milking phase and total milking time with the lowest peak and average flow rate. Milk yield was the highest in Holstein-Friesian breed. The highest peak and average flow rate with the shortest main milking phase duration and total milking time was observed in Brown-Swiss breed. Breed specific premilking teat preparation routine should be performed to remove high milk yield in shortest time.

Key words: cow, prestimulation, milking, milkability

GROWTH AND MORTALITY OF SUCKLING RABBITS

Martina PLANINC¹, Ajda KERMAUNER¹, Špela MALOVRH¹ and
Milena KOVAČ¹

¹ *University of Ljubljana, Biotechnical faculty, Department of Animal Science*

Corresponding author: **Martina PLANINC**, +386013203868;
martina.planinc@bf.uni-lj.si

Rabbits are usually smaller and mortality is higher in large litters. The aim of the study was to estimate effects on mortality and growth in rabbits. The study was carried out in Slovenian SIKA sire line. In total, 430 kits of 60 does were included. In the analyses the effects of parity, number of liveborn kits and number of teats were analysed. Initial weight was included in the model for mortality, while age was included in the model for growth. Parity, litter size and teat number affected all traits, except on mortality. Body weight varied according to age. A total of 430 kits were observed, corresponding to an average litter size of 7.8 kits born, 7.3 kits born alive and 6.2 kits weaned. The birth to weaning mortality was 15.35% and mortality has steadily declined with age. Average weight up to age of three days was 75 g and at weaning 1035 g. Kits in smaller litters had a higher growth rate.

Key words: rabbit, growth, mortality, litter size

PRELIMINARY RESULTS ON THE EFFECT OF CHRONIC T-2 TOXIN EXPOSURE IN RABBIT BUCKS

Gábor TORNYOS^{1*}, Sándor CSEH³, Zsolt MATICS², László KAMETLER¹, Veronika RAJLI¹, Zsófia BODNÁR¹, Miklós RUSVAI³, Míra MÁNDOKI³, and Melinda KOVÁCS^{1,2}

¹Kaposvár University Faculty of Animal Science, ²Research Group of Animal Breeding and Hygiene of the Hungarian Academy of Sciences and Kaposvár University, ³SZIU Faculty of Veterinary Science, Budapest

Corresponding author: **Gábor TORNYOS**, +3682505970; tornyos.gabor@ke.hu

The aim of the present study was to examine the chronic effect of T-2 toxin on feed consumption and sperm quality. Pannon White (n=10/group) male rabbits (weight: 4050-4500 g, age: 9 month) trained to ejaculate into artificial vagina were exposed to 0 (control), 0.05, 0.1 or 0.2 mg/animal/day of T-2 toxin by gavage for 63 days. On the 63rd day of the experiment semen was collected with an artificial vagina, and the following traits were evaluated: pH, concentration, morphology, motility with CASA, concentration of seminal plasma components such as citric acid, zinc and fructose. At the end of the experiment animals were necropsied and the testes were subjected to histopathological examination. T-2 toxin in 0.1 mg and 0.2 daily dose significantly decreased feed intake in the first two weeks but no significant difference between groups were observed from the 4th week. Among the sperm quality traits examined only the ratio of spermatozoa with cytoplasmic droplets increased by 320% in animals treated with the highest dose of T-2. The 0.1 mg/animal/day toxin exposure resulted in a slight hyperplasia of the Leydig cells, while the highest dose (0.2 mg/animal/day) caused hyperaemia, increased proliferative activity and hyperplasia of the Leydig cells. According to the preliminary results it seems, that adult male rabbits may tolerate the concentration of 0.05 mg/animal/day T-2 toxin.

Key words: T-2 toxin, rabbit, sperm quality

1. PRODUCTION SYSTEMS: MANAGEMENT AND HEALTH

1.2. POSTERS

INFLUENCE OF INFECTION WITH CAPRINE ARTHRITIS ENCEPHALITIS VIRUS ON MILK PRODUCTION OF FRENCH ALPINE GOATS IN CROATIA

Bruna TARIBA^{1*}, Antun KOSTELIC¹, Krešimir SALAJPAL¹, Besi ROIC², Danijel MULC³, Darko JURKOVIĆ³, Dragica SALAMON¹

¹*Department of Animal Science, Faculty of Agriculture, University of Zagreb;* ²*Croatian Veterinary Institute;* ³*Croatian agriculture agency*

Corresponding author: B. TARIBA, +38512393992; +3852393947; btariba@agr.hr

In our research we wanted to explore if there was an influence of CAEV infection on estimated milk yield per lactation, length of lactation and milk composition of 259 French alpine goats from production farms in NW Croatia. Also, since our previous results indicate high frequency of clinical arthritis, our intention was to evaluate its influence as well. All goats were kept under similar intensive feeding and management conditions. Milk control was performed using the ICAR method A4 during the year 2009. At the same time, blood samples were collected and presence of CAEV antibody in the sera was detected using enzyme-linked immunosorbent assay (ELISA). Diagnose of arthritis was noted by clinical inspection of joints. The influence of infection status on milk yield, length of lactation and milk composition (fat, protein and lactose) was tested by analysis of variance (PROC GLM). Although in some animals CAEV can be considered as the causative agent, other possible causes have not been excluded. Furthermore, number of CAEV infected animals showed no signs of clinical arthritis. Therefore, influence of infection with CAEV and clinical form of arthritis on milk yield and composition have been observed separately. CAEV was serologically confirmed in 37% of goats. In addition, 24% CAEV positive animals were expressing clinical symptoms of arthritis. Strong influence of serological status on all recorded traits has been confirmed. Presence of clinical arthritis has confirmed influence only on protein and fat content in milk indicating other possible arthritis causes with lower influence on milk production than the one assessed for CAEV infection.

Key words: clinical arthritis, caprine arthritis encephalitis virus, estimated milk yield, lactation length, milk quality, goats

DIFFERENCES IN CARCASS AND MEAT QUALITY BETWEEN ORGANICALLY REARED COCKS AND CAPONS

Marko VOLK¹, Jernej MALENŠEK¹, Maja PREVOLNIK¹, Martin ŠKRLEP², Blaž ŠEGULA², Marjeta ČANDEK-POTOKAR^{1,2},
Martina BAVEC*¹

¹ *Maribor University, Faculty of agriculture and life sciences;* ² *Agricultural institute of Slovenia*

Corresponding author: Martina BAVEC +38623209049; +38626161158;
martina.bavec@uni-mb.si

The aim of the present study was to compare carcass and meat quality traits of ecologically reared capons and cocks. The experiment comprised 60 layer-type Slovenian hybrid Prelux-G chickens. Half of the animals were caponized at the age of 52 days (app. 0.5 kg body mass) and another half were left entire males. All chickens were reared on the same farm respecting requirements for ecological farming. Chickens were fed commercial feed mixtures combined with the free access to pasture. After the slaughter (185 days), the chickens were dissected and main carcass parts were weighed. Meat quality (pH, colour, water-holding capacity) and chemical composition (protein, water, intramuscular fat) were determined. Birds of both groups had similar weight of carcass and body parts, except for weight of the thighs with drumsticks and offal weight, which were significantly lower in capons. The main differences in carcass traits appeared in the abdominal fat tissue. Capons had more abdominal fat. Meat physico-chemical characteristics (pH, drip loss) were similar in both groups, except for the colour. Capons had lighter (higher Minolta L*value) and less red (lower Minolta a* value) colour of meat as cocks. There was no difference between capons and cocks in the content of muscle proteins, water and intramuscular fat.

Key words: poultry, caponization, carcass quality, meat quality

PHYSIOLOGICAL AND BEHAVIOURAL RESPONSES IN PIGLETS SUBMITTED TO CASTRATION: PRELIMINARY STUDY

Chiara LONARDI¹, Marta BRSCIC¹, Simona NORMANDO²,
Annalisa SCOLLO¹, Annalisa STEFANI³, Flaviana GOTTARDO¹

¹Dipartimento di Scienze Animali, ²Dipartimento di Scienze Sperimentali Veterinarie
³Istituto Zooprofilattico Sperimentale delle Venezie

Corresponding author: **Chiara LONARDI**; +390498272660;
chiara.lonardi.1@studenti.unipd.it

With the perspective to test drugs that may reduce pain due to surgical castration, this preliminary study tries to find out a robust and valid method for pain assessment in piglets. In the present study three treatments were applied: handling (H), tail docking (TD) and surgical castration + tail docking (CTD). To evaluate pain response to the treatments different variables were analyzed: movement latency (time from placing back the piglet inside the farrowing crate after treatments and its first movement towards the nest or the sow), rectal temperature and plasma cortisol and lactate levels. Movement latency was measured for all treatments. Rectal temperature was measured before treatments H and CTD, and 1, 3, 5, 24 hours later. Blood samples for cortisol and lactate determination were collected 1 hour before treatments H and CTD, right after and 3, 5, 24 hours later. The significant increase of movement latency for CTD compared to H showed that pain can be assessed by this type of measure. Rectal temperature was significantly affected by time ($P < 0.01$) but not by treatment likely due to several factors that might have confounded the studied effect. Cortisol was significantly affected by interaction time*treatment ($P < 0.01$) particularly due to the high peak for CTD right after the surgical procedure. Lactate was modified only by time ($P < 0.01$). This preliminary study suggests that a non invasive and easy measure such as movement latency is a promising method to assess pain in piglets after surgical castration and tail docking.

Key words: piglets, castration, cortisol, lactate, pain assessment

CHANGES OF SOME PARAMETERS OF DAIRY COWS TEAT DURING MACHINE MILKING

Miomir STOJNOVIĆ¹, Damir ALAGIĆ¹

¹ *Križevci College of Agriculture*

Corresponding author: **Miomir STOJNOVIĆ**, +38548279190; mstojnovic@vguk.hr

The paper deals with the changes of some parameters of dairy cows teat caused by machine milking. Ultrasonographic scanner GE Medical Systems LOGIQ 100 PRO with linear array VE 5 with 5 MHz probe was used for scanning the teats. Scanning was conducted on nineteen cows of Holstein-friesian breed. The cows were housed in a free stall barn and milked in a herringbone milking parlour 2x3 with Alfa-Laval milking system with Duovac milking units. Teat scanning was done just before morning milking and immediately after milking on the right side of the udders for front and rear teats. The following parameters were measured: teat canal length (TCL), teat end width (TEW), teat cistern width (TCW) and teat wall thickness (TWT). Ratio between teat wall thickness and teat cistern width (TWT/TCW) before and after milking was calculated. Length of teat canal for the front right teat increased in average for 12.55% after milking and 23.61% for the rear right teat. Teat end width of the front and rear right teat increased after milking for 1.25% and 4.79%, respectively. Mean teat cistern width of the front right teat decreased after milking for 22.27%, while for the rear right teat mean decrease was 25.63%. Teat wall thickness of the front and rear right teat increased after milking for 5.22% and 17.26% respectively. Ratio between teat wall thickness and teat cistern width (TWT/TCW) changed from 0.635 before milking to 0.860 after milking for the front right teat and from 0.698 to 1.101 for the rear right teat.

Key words: machine milking, dairy cows, teat, teat parameters, ultrasonographic scanning

**NON INVASIVE (CT) INVESTIGATION OF THE LUNG IN
Bordetella bronchiseptica INFECTED PIGS**

Roland PÓSA¹, Melinda KOVÁCS¹, Tamás DONKÓ¹, Imre REPA¹,
Tibor MAGYAR²

¹ Kaposvár University, Faculty of Animal Science; ² Veterinary Medical Research
Institute of the Hungarian Academy of Sciences, Budapest

Corresponding author: **Roland PÓSA**, +3682505970; posa.roland@ke.hu

Bordetella bronchiseptica produced pneumonia was studied in young piglets. At the beginning of the experiment, 30 artificially reared 3-day-old piglets were divided into two groups: group A – uninfected piglets, control group (n=10) and group B – piglets infected with *B. bronchiseptica*, experimental group (n=20). The *B. bronchiseptica* infection (10^6 CFU/ml) was performed on day 4. In Group B, clinical signs including mild serous nasal discharge, sneezing, panting, and hoarseness appeared from day 4. Computed tomography (CT) performed on day 16 demonstrated lung lesions attributable to colonisation by *B. bronchiseptica* in the infected pigs. The gross pathological findings confirmed the results obtained by CT.

Key words: *Bordetella bronchiseptica*, porcine respiratory disease complex, computed tomography

EFFECT OF SIMULATED TRANSPORT VIBRATION ON EGG HATCHABILITY EFFICIENCY

Feizollah SHAHBAZI*¹, Saeid MOHAMADZADEH², Hassan KARIMIAN³

¹Department of plant production, Lorestan University; ²Department on Animal science, Lorestan University; ³Undergraduate student of animal department - Lorestan University

Corresponding author: Feizollah SHAHBAZI, +986614200012; +986614200289; feizollah.shahbazi@gmail.com

Vibration generated during road transport by vehicles has a great significance on agricultural products damage process. The damage is depended on the physical and physiological properties of the product and properties of the applied force (static, dynamic and vibration). This research was conducted to evaluate the effects of vibration frequency on different levels. At first a laboratory vibrator was designed which simulates the road transportation under laboratory conditions, and used to obtain factors influencing the damage during eggs transportation. The damage was described as a difference of eggs hatchability efficiency. Four vibration frequencies of 5, 7.5, 10 and 12.5 Hz and three positions in bin of bottom (40 cm), middle (80 cm) and top (120 cm) at constant acceleration of 0.5 g were used. Fertile eggs were treated and incubated during 21 days. Data was analyzed using RCD method by SPSS ver.11.5. The results of laboratory test indicated that vibration frequency of 12.5 Hz significantly affected the hatchability. Vibrations frequency 5, 7.5 and 10 Hz did not show any effect on hatchability. Low and high positions did not affect the hatchability. Transportation of fertile eggs on roads is recommended with the use of soft tampon materials.

Key words: vibration, transportation, simulation, egg, hatchability

2. ANIMAL NUTRITION

Chairs: Cs. Szabó, K. Salajpal

2.1. ORAL PRESENTATIONS

EFFECT OF LINSEED SUPPLEMENTATION ON CARCASS, MEAT QUALITY AND FATTY ACID COMPOSITION IN PIGS

Matjaž ČERVEK¹, Mihael GEISTER¹, Maja PREVOLNIK², Martin ŠKRLEP³, Marko OCEPEK², Maksimilijan BRUS², Marko GUNGL², Zorica ABRAHAM-PANIČ⁴, Marjeta ČANDEK-POTOKAR^{2,3}, Dejan ŠKORJANC^{*2}

¹Emona, Feed research center; ²Maribor University, Faculty of agriculture and life sciences; ³Agricultural institute of Slovenia; ⁴Panvita d.d.

Corresponding author: **Dejan ŠKORJANC** +386 2 320 90 25; +386 2 616 11 58; dejan.skorjanc@uni-mb.si

Meat is generally considered as the rich source of saturated fatty acids (SFA) that are often associated with some critical diseases. From the nutritional point of view favourable balance between polyunsaturated (PUFA) and saturated fatty acids (SFA) and between *n-6* and *n-3* fatty acids is important. In pigs, which are monogastric, the fatty acid composition can be manipulated through feeding. The effect of linseed supplementation on carcass, meat quality and fatty acid profile of fat tissue was studied. No differences in carcass and meat quality traits were observed, the exception being drip loss that was lower in pigs supplemented with linseed. As regards fatty acids, linseed supplementation led to the increased content of unsaturated, polyunsaturated and *n-3* fatty acids and decreased content of saturated fatty acids and *n-6/n-3* ratio in the subcutaneous and intramuscular fat of pigs.

Key words: pig, linseed, carcass quality, meat quality, fatty acids

THE EFFECT OF COENZYME Q10 AND LIPOIC ACID ADDED TO THE FEED OF HENS ON PHYSICAL CHARACTERISTICS OF EGGS

Dušan TERČIČ¹, Barbara KOTNIK¹, Gregor GORJANC¹, Petra
JAZBEC KRIŽMAN², Antonija HOLCMAN¹

¹ *University of Ljubljana, Biotechnical Faculty, Department of Animal Science;*
National Institute of Chemistry

Corresponding author: Dušan TERČIČ, tel. +38613203915; fax +38617241005;
dusan.tercic@bf.uni-lj.si

This study was designed to investigate whether inclusions of coenzyme Q10, alpha lipoic acid and their combination into diets of hens improve egg quality characteristics. Forty-eight, 33 weeks old Lohmann Brown hens were assigned randomly to four groups of 12 hens each and fed either a basal diet or basal diet supplemented with 2 g/kg coenzyme Q10, 0.4 g/kg alpha lipoic acid and 2 g/kg coenzyme Q10 plus 0.4 g/kg alpha lipoic acid. The diets were fed for 12 weeks. Eggs were weekly examined for interior or exterior quality characteristics. There were no effects of dietary treatments on egg shape index. Coenzyme Q10 supplementation resulted in a reduction in egg shell colour (darker shells) and yolk colour (paler yolks) and higher incidence of blood and meat spots, which reduce the internal quality of the egg. Alpha lipoic acid had no effect on egg weight, egg shell colour, egg shell density, egg shell weight, egg shell thickness, yolk colour, incidence of blood and meat spots but increased shell strength, albumen height and Haugh units values were noted. Egg shell strength for hens supplemented with alpha lipoic acid was greater than for control hens. The results of the experiment indicated that alpha lipoic acid supplementation to the diet of layers may be of practical value due to the increased egg shell strength and better albumen characteristics without any adverse effect on other egg quality traits.

Key words: hens, coenzyme Q10, alpha lipoic acid, egg quality

LATE GESTATIONAL UNDERNUTRITION ALTERS PLASMA IGF-1 CONCENTRATION DURING SUBSEQUENT LACTATION IN EWE

Ali KIANI^{1*}, Mette Olaf NIELSEN², Andre CHWALIBOG²

¹*Animal Sciences Group, Faculty of Agricultural Sciences, Lorestan University;*

²*Department of Basic Animal and Veterinary Sciences, University of Copenhagen*

*Corresponding author: **Ali KIANI**, kiani.a@lu.ac.ir

The objective of this study was to investigate the effects of undernutrition during late gestation on plasma concentration of insulin-like growth factor (IGF1), leptin, insulin and glucose in pregnant and lactating ewes. Ten twin-bearing shropshire ewes were fed either adequately (AN; 100% energy and protein requirements) or restrictedly (RN; about 60% of energy and protein requirements) fed during the last six weeks of gestation. Ewe's blood samples were taken at 50, 28 and 10 days *pre-partum* as well as at lambing and 7, 17 and 35 days *post-partum*. At lambing plasma glucose concentrations sharply increased in both groups and it was significantly lower in RN ewes in comparison with AN ewes. Plasma concentrations of insulin and leptin were not affected by late gestational undernutrition. Plasma IGF1 concentrations in RN ewes (78 ± 8 ng/ml) was significantly lower ($P < 0.05$) than that in AN ewes (110 ± 8 ng/ml). Plasma IGF1 decreased in RN ewes during late gestation and then increased sharply at lambing and during first month of lactation. In contrast IGF1 concentration was relatively constant both *pre* and *postnately* in AN ewes. IGF1 values in restricted fed ewes were significantly lower than values in adequately fed ewes during gestation. Surprisingly IGF1 plasma in RN ewes was significantly lower at 35 days (110 vs. 164 ng/ml) *post-partum* in comparison with those in AN ewes. In conclusion, results showed late gestational undernutrition causes a decrease in plasma glucose and IGF1 at parturition as well as during late gestation. In addition, late gestational undernutrition seems to have longer term effect on plasma IGF1 even when ewes are adequately fed during lactation.

Key words: undernutrition, gestation, hormones, sheep

A COMPARISON AMONG ANALYTICAL METHODS TO ASSESS FATTY ACIDS AND CONJUGATED LINOLEIC ACIDS (CLA) CONTENT AND REPEATABILITY OF RUMINANT FAECES

Giacomo CESARO*, Luca GRIGOLETTO, Giovanni BITTANTE,
Stefano SCHIAVON

Department of Animal Science, University of Padova

*Corresponding author: Giacomo CESARO, +390498272777;
giacomo.cesaro@studenti.unipd.it*

Methods to determine fatty acids (FAs) and CLA contents of faeces should limit isomerisation, provide a good repeatability of the measures, avoid the use of harmful substances. Three methods of FAs extraction from faeces for GC analysis were compared: Est-DF_{tol}, based on extraction and esterification of FAs contained in dry faeces using Na-methoxide, methanolic-HCl and toluene as solvent; Est-EE_{tol}, based on acid-base extraction and esterification of FAs on the faecal ether extract (EE), using toluene as solvent; and AEst-EE_{hept}, based on an acid catalyzed esterification of FAs contained in EE, using *n*-heptane as solvent. Faeces were collected from bulls receiving 0, 8 and 80 g/d of rumen protected CLA (rpCLA). The faeces of 9 bulls (3 for each dose) were analysed in triplicates by each method. Methods were compared by linear regression. The measurements performed with Est-EE_{tol} and AEst-EE_{hept} regressed against those of Est-DF_{tol}, evidenced, in particularly for CLA isomers and their sum, positive intercepts and slopes significantly lower than the unity. The proportions of c18:2,*t*9,*t*11 found with Est-DF_{tol} and AEst-EE_{hept} were correlated to the dose of rpCLA ($R = 0.87$ and 0.51 , respectively), whereas those found with Est-EE_{tol} did not ($R = 0.17$). The Est-DF_{tol} method is recommended because it minimizes the isomerisation of the polyunsaturated fatty acids and yields a more accurate measurement of the FAs profile.

Key words: CLA, faeces, fatty acid, gas chromatography, repeatability

CELLULAR IMMUNE RESPONSE OF WEANED PIGS FED DIET SUPPLEMENTED WITH AN ESSENTIAL OIL

Veronika HALAS^{1*}, Imre NOCHTA², Zsuzsanna PÁSTI¹,
Csaba SZABÓ¹, Róbert TÓTHI¹, János TOSSENBERGER¹,
László BABINSZKY³

¹ Kaposvár University, Department of Animal Nutrition; ² Agrokomplex C.S.
ZRT; ³ University of Debrecen, Department of Feed- and Food Biotechnology

Corresponding author: **Veronika HALAS**, halas.veronika@ke.hu

The objective of the present study was to investigate the effect of an essential oil product on growth performance and cellular immune response of 28-day-old weaned piglets. A total of 348 piglets (50% gilts, 50% barrows) were assigned to three dietary treatments (6 pens/trt). The basal diet was a commercial feed that was supplemented without any growth promoter (NC), with antibiotic growth promoter of 40 ppm avilamycin (PC), or with 0.25 g of an essential oil product (EO) per kg of feed. All pigs were immunized by inactivated Aujeszky's disease virus vaccine at week one and three of the experiment (28- and 44-days-age). Blood samples were taken four times (on day one, 16, 24, 32 of the experiment) for lymphocyte stimulation (LST) tests with ConA, PWM, PHA used as non-specific and Aujeszky virus used as specific mitogens from 2 pigs/pen. All piglets were individually weighed on day 0, 8, 16, 24 and 32 of the trial. There was no significant difference among average daily gain, feed intake and feed conversion ratio of piglets fed different dietary treatments. The non-specific LST test at the 4th blood sampling showed higher values in pigs received feeds with essential oil supplementation (EO) than that of the positive (PC) and negative control (NC) groups ($P < 0.05$). However, no significant difference in specific immune response of pigs in different dietary treatments was found. It can be concluded that essential oil supplementation may enhance the non-specific immunocompetence of 28-day-old weaning pigs without compromising their growth performance.

Key words: essential oil, weaned piglets, non-specific immunity, specific immunity

2. ANIMAL NUTRITION

2.2. POSTERS

HABITAT USE AND ACTIVITY OF ROE DEER (*Capreolus capreolus* L.) IN EASTERN CROATIA

Dražen DEGMEČIĆ¹, Robert GROS¹, Tihomir FLORIJAČIĆ²,
Siniša OZIMEC² Ivica BOŠKOVIĆ²

¹*Hrvatske šume Ltd., Forest Administration Osijek;* ²*Faculty of Agriculture, Josip Juraj Strossmayer University of Osijek*

Corresponding author: Tihomir FLORIJAČIĆ, + 38531224275; flory@pfos.hr

The activity of roe deer was surveyed in five habitats in the Haljevo Forest (Baranja Region, Eastern Croatia), during the 1965/1966 hunting season. The aim was to compare the habitat preferences and to determine differences in the number of animals observed in the study period, by taking into account: period of the year, height of understory layer in forest stands and weight of fat deposit around kidney. The animals caught by net were marked and their activities have been observed. A total of 532 sightings of individuals were noted on all five habitats, and the abundance of roe deer was 228 individuals. During the fawning period in the spring, the highest number of animals (n=55) was recorded in black locust stand, followed by oak stands with thick understory layer (n=61) and hornbeam stands with oak (n=51). Regarding the quality of habitat as a food source, the highest number (n=196) was in the hornbeam stand with oak, compared to black locust stand (n=59) and oak stand with thick understory layer (n=20). Fitness of roe deer is estimated by measuring kidney fat from 96 culled individuals. Mean weight of kidney fat was significantly higher in the oak stand with thick understory layer (104.71 g) than in young oak stand (55.83 g). In comparison to black locust stand (81 g) and hornbeam stand with oak (96.46 g), the value was higher but not significantly higher, indicating the importance of the oak acorn in roe deer diet.

Key words: roe deer, activity, habitat, shelter, kidney fat

**INFLUENCE OF DIFFERENT LEVELS OF PHYTASE
ENZYME ON JAPANESE QUAIL (*Coturnix japonica*)
PERFORMANCE**

Nasrollah, VALI*, Mohammad Ali, JALALI

Department of Animal Sciences, Faculty of Agriculture Islamic Azad University,

*Corresponding author: Nasrollah, VALI, +98 381 3361000-3; +98 3813361093;
nasrollah.vali@iaushk.ac.ir*

An experiment was conducted to study the effect of phytase enzyme (Natuphos 500) supplementation in Japanese quail (*Coturnix japonica*) (3 to 45 days of age) on body weight, carcass performance, percentage of tibia bone ash and tibia phosphorus. Data were analyzed as a completely randomized design arranged with five levels (150, 300, 600, 1200 and 2400 FTU/Kg) of phytase enzyme as treatments 1, 2, 3, 4 and 5, respectively, and two control groups (positive and negative controls). None of the phytase levels had effect on carcass yield at 45 days of age ($p < 0.05$), except first treatment with 70.06% of carcass yield that was significantly different than treatment 5 ($p < 0.01$). The treatment 5 for percentage of tibia ash was 59.83% that was significantly different compared to the other treatments ($p < 0.01$). Treatment 3 increased ($p < 0.01$) phosphorus of tibia ash at 45 days of age (240.22 mg). Experimental replicates were not significantly different in any stage ($p > 0.05$). Female quails at body weight, slaughter weight, carcass weight without viscera and legs weight were better than male ($p < 0.01$), but male quails at carcass yield (69.06%) were significantly different ($p < 0.01$) in contrast to the females (66.30%).

Key words: Japanese quail, phosphorus, phytase enzyme

IMPACT OF NANOSIL DIETS ON GROWTH PERFORMANCE IN BROILERS

Mohammadzadeh S¹., Changai Kh.¹, Khosravinia H¹., Karimi H².

1 Department of animal science, Lorestan University; 2 Internal medicine, Lorestan University

Corresponding author: MOHAMMADZADEH Said

saidmohammadzadeh@yahoo.co.nz

Nanotechnology imposes significant effect on life. Antiseptic activity and antimicrobial properties of silver are observed when nano particles are incorporated in water and diet. We have investigated the effect of different diets containing silver nano particles (nanosil) on growth performance of broiler chickens. 400 1- day- old broiler chickens were reared up to 45 days of age. Birds were assigned to 5 treatments with 4 replications. Each replication set of 20 birds was housed in a pen area (1*2*0.80 m). Birds received prestarter and grower diet. The five treatments were formulated as recommended by the NRC of different combination of prestarter and grower diets. T1 was composed of crushed starter and grower, T2 of usual pellet, T3 of nanosil. T4 had nanosil starter and usual pellet grower, and T5 pellet starter and nanosil grower. Feed intake and feed efficiency were determined. Data was analyzed by RCD with SPSS version 11.5. At the beginning of the experiment there were no significant differences in live body weight. At 21 days, crushed ration (T1) showed lower live weight than other treatments (478g). At the end of 21 and 28 days, live weight was increased by nanosil grower ration. In T5 the highest body weight occurred (1129gr). In 31 days, nanosil stimulated growth significantly. The lowest live weight was observed in T1 and T4. In 40 days, no significant difference was found between treatments T2, T3, T4 and T5 but lowest live weight was in T1. Nanosil ration of prestarter has negative effect on live weight. This study showed the prestarter diet containing nanosil did not have the effect on growth performance and that it could be recommended to use grower ration containing nanosil.

Key words: nanosil, broiler, grower, starter, feed efficiency, feed intake

3. ANIMAL PRODUCT QUALITY

Chairs: M. Čandek-Potokar, S. Žgur, D. Karolyi

3.1. ORAL PRESENTATIONS

CONSUMERS' ATTITUDES TOWARDS FARM ANIMAL WELFARE AND THEIR INFLUENCE ON MEAT CONSUMPTION

Marija CERJAK*¹, Danijel KAROLYI¹, Željka MESIĆ¹

¹ *University of Zagreb Faculty of Agriculture*

Corresponding author: Marija CERJAK, +38512393739; +3852393745; mcerjak@agr.hr

The aim of this paper was to examine Croatian consumers' attitudes towards meat producing farm animal welfare (AW). The survey conducted with 102 meat consumers in Zagreb revealed that consumers believe in importance of AW but most of them do not consider it when buying meat. Three segments, differing in their attitudes towards AW, were identified by using cluster analysis: the most numerous (44%) are mostly concerned about AW and they eat meat less often than others; the second group (37%) considers AW as an important issue, but they believe that modern food production not following high AW standards is necessary. The smallest segment (19%) is rather indifferent towards AW compared to others, and they consider taste of meat as more important than the way of its production.

Key words: Croatia, animal welfare, consumers' attitudes, segmentation

CARCASS QUALITY OF SLAUGHTERED CIKA AND BROWN CATTLE IN SLOVENIA

Mojca SIMČIČ*, Marko ČEPON, Silvester ŽGUR

University of Ljubljana, Biotechnical Faculty, Department of Animal Science

Corresponding author: Mojca SIMČIČ, +38613203913; +38617241005; mojca.simcic@bf.uni-lj.si

The aim of the study was to compare carcass traits between Cika and Brown cattle of all slaughter categories. The data used were collected in Slovenian slaughterhouses from 2007 to 2010. After the slaughter carcass weight was recorded and carcass conformation and fatness were scored according to the EUROP system. Net daily gain was calculated. Data were analysed by GLM procedure of statistical package SAS/STAT considering breed, month of the slaughter and year of the slaughter nested within the breed as fixed effects. Cika bulls (under 24 months old) were two months younger at slaughter (20.2 months) and achieved lower carcass weight (266.7 kg) compared to Brown bulls (22.4 months, 330.0 kg). Also in all other categories except in calves under eight months old, Brown cattle had higher carcass weight. Bulls under 24 months old, steers, cows and calves over eight to 12 months old of Brown cattle were older at slaughter compared to Cika breed. Net daily gain was also higher in all slaughtered categories of Brown cattle. Even if the slaughtered Brown cattle had heavier carcass weight compared to Cika cattle there was almost no significant difference in carcass conformation. Carcasses of Cika bulls under 24 months old had conformation 6.4 while Brown bulls 6.3. Likewise carcasses of Cika calves over eight to 12 months had higher conformation score (5.7) than Brown (4.8) calves. Fatness was higher in Brown bulls, steers and heifers compared to Cika cattle, while Cika cows had higher fatness than Brown cows.

Key words: cattle, Cika, Brown, carcass quality

CARCASS CLASSIFICATION MEASUREMENTS IN PIGS AS AFFECTED BY THE OPERATOR AND ABATTOIR

Maja PREVOLNIK¹, Peter ŠLAMBERGER², Manca KNAP³, Dejan ŠKORJANC¹, Marjeta ČANDEK-POTOKAR*^{1,3}

1 Univerza v Mariboru, Fakulteta za kmetijstvo in biosistemske vede, 2 Bureau Veritas, d.o.o. Ljubljana, 3 Kmetijski inštitut Slovenije

Corresponding author: Marjeta ČANDEK-POTOKAR, +38612805124; +3862805255; meta.candek-potokar@kis.si

The aim of the present study was to test a possible way of statistical checking of the measurement uncertainty in pig carcass classification; *i.e.* to monitor deviations between operators when measuring fat and muscle thickness used for meat percentage calculation. For that purpose, data were obtained from the official classification body Bureau Veritas for the year 2009, which comprised eight operators working in five abattoirs. An analysis of covariance was performed using a model with the effects of the operator, carcass weight as a covariate and their interaction. The equality of the regression lines (regression coefficients and intercepts) was tested for various operators. Regression lines differed significantly between the operators, however all pair-wise comparisons were not conclusive since the operators work only in one or two abattoirs, the abattoirs have different suppliers *i.e.* different origin of pigs. In order to differentiate between the operator and the abattoir effect we further compared i) different operators working in the same abattoir and ii) same operator working in different abattoirs. The deviations in measurements of muscle and fat (often reflected also in meat percentage) were more important in the case of the same operator working in different abattoirs, than in the case of different operators working in the same abattoir.

Key words: pig, carcass classification, operator, uncertainty, statistical control

GROWTH RATE, SLAUGHTER TRAITS AND MEAT QUALITY OF LAMBS OF THREE ALPINE SHEEP BREEDS

Erika PELLATTIERO, Alessio CECCHINATO, Massimo DE MARCHI, Mauro PENASA, Nicola TORMEN, Stefano SCHIAVON, Martino CASSANDRO, and Giovanni BITTANTE

Department of Animal Science, University of Padova

Corresponding author: **Erika Pellattiero**, +30498272614;
erika.pellattiero@studenti.unipd.it

A fattening and slaughter trial was carried out on 36 lambs of Alpagota, Brogna and Foza sheep breeds native of Veneto Region Alps (six male and six female lambs per breed) divided in three groups depending on the type of feed used: pasture, hay and concentrate, hay and concentrate supplemented with conjugated linoleic acid. Lambs were slaughtered at 225 days (mean weight: 30 kg). *Infra-vitam* and *post-mortem* data were analyzed by using a linear model that included the cross-classified effect of breed, sex, feeding system and age of lambs as linear covariate. The three breeds showed some specificity: Foza lambs, of both sexes, were larger-sized and faster growing, with a lower incidence of gastro-intestinal tract and lower cooking losses of the hind-leg samples compared to the other two middle-sized breeds. Alpagota breed tended to be leaner, with heavier shin and greater cooking losses than Brogna breed. In conclusion the three Alpine breeds of the Veneto Region confirmed to be able to produce lamb carcasses and meat with valuable characteristics that can be exploited through typical products and food preparation in local markets and gastronomy, according to the tradition. The valorisation of these productions can be an important instrument for *in situ* conservation of these breeds.

Key words: lamb, meat quality, carcass traits, breed

APPLICATION OF INFRARED SPECTROSCOPY IN HONEY ANALYSIS

Lidija SVEČNJAK*¹, Nikola BILIŠKOV², Dragan BUBALO¹,
Domagoj BARIŠIĆ¹

¹ Faculty of Agriculture University of Zagreb, Department of Fisheries, Beekeeping and Special Zoology; ² Rudjer Boskovic Institute, Division of Organic Chemistry and Biochemistry

Corresponding author: **Lidija SVEČNJAK** +38512393977; +38512315 300;
lsvecnjak@agr.hr

The chemical composition and sensory characteristics within different honey types vary significantly. In order to determine botanical origin of honey, it is necessary to conduct rather complicated and time consuming analytical methods. IR spectroscopy has not been experimentally explored yet for honey analysis in Croatia, so the aim of this study was to determine claimed botanical origin of honey using both, standard and alternative (IR spectroscopy) methods, for the purpose of their comparison. Altogether 144 samples of nine different unifloral honey types (black locust, sweet chestnut, lime, sage, heath, rosemary, lavender, mandarin and strawberry tree) were collected from different Croatian regions directly from the beekeepers. In order to confirm claimed botanical origin of collected honey samples, melissopalinalogical analysis, moisture and electrical conductivity measurements were conducted. Infrared spectra of honey samples were recorded using the ABB Bomem MB102 Fourier-transform infrared spectrometer (FT-IR spectrometer) Selected IR spectra data were analyzed by multivariate factor analysis, principal components analysis (PCA). Preliminary PCA of IR spectra showed significant clustering of the analyzed samples by botanical origin. The results of this study showed that IR spectroscopy provides equally reliable results, but also represents rapid and cheap analytical tool in comparison to commonly used standard analytical methods. This research has also provided the first insight in infrared spectra of Croatian honeys.

Key words: honey, botanical origin, standardized analytical methods, infrared spectroscopy

**EFFECTS OF ADDED BOAR TAIN T SUBSTANCES
(SKATOLE AND ANDROSTENONE) ON THE SENSORY
QUALITY OF PORK**

Agnes KIRSCHING, Gyorgy BAZAR, Szilvia SZVATH, Robert
ROMVARI

Kaposvár University Faculty of Animal Science

*Corresponding author: Agnes KIRSCHING, +3682505800/357;
kirschingagi@gmail.com*

Meat samples with known levels of androstenone and skatole were used for sensory evaluation by trained panel and were characterized with an AlphaMOS Fox 4000 electronic nose. In case of skatole women tended to be more sensitive than men. In contrast, for androstenone the sensitivity was independent of sex. Results obtained with PanelCheck V.1.3.2. software show that the panellists were more sensitive to the samples with both substances, than the samples with only androstenone or skatole. Discriminant Factor Analysis (DFA) model classification based on electronic nose sensory data shows 100% correct classification of the samples with only androstenone and only skatole. With using of all samples except control samples in development of discriminant analysis (DF) model, three groups were classified with 80% success: only androstenone, only skatole and the different combination of androstenone and skatole levels. Groups with slight or definite odour were classified successfully with discriminant analysis based on data obtained with two characteristic sensors (81.3% in cross validation). The preliminary results reported in this paper show that measurements of compounds with an AlphaMOS device might be a useful technique for boar taint evaluation.

Key words: boar taint, skatole, androstenone, electronic nose, sensory panel

3. ANIMAL PRODUCT QUALITY

3.2. POSTERS

MONITORING OF PHYSICOCHEMICAL CHANGES IN FROZEN FISH MUSCLE TISSUE

František JEŽEK, Hana BUCHTOVÁ

University of Veterinary and Pharmaceutical Sciences Brno

Corresponding author: **František JEŽEK** +420541562754; +420541321230;
fjezek@vfu.cz

The aim of the study was to monitor physicochemical parameters (pH, nitrogen trimethylamine N-TMA, total volatile basic nitrogen TVBN, free fatty acids FFA, peroxide value and thiobarbituric acid assay TBA) of postmortal changes in muscle tissue of silver carp (*Hypophthalmichthys molitrix*) during a period of storage at -18°C. Fresh silver carp samples and samples after three, six, nine and 12 months of storage were tested. The degree of acidification during the experiment was insignificant ($P > 0.05$). Proteolytic changes were almost stopped and TVBN levels remained unchanged ($P > 0.05$), while N-TMA levels fluctuated significantly ($P < 0.01$) between months 3 and 12. The essential were lipid hydrolysis and oxidation, which caused a significant increase in FFA values ($5.89 \pm 0.99\%$ total lipids as oleic acid), peroxides (9.90 ± 2.83 mekv $O_2 \cdot kg^{-1}$) and TBA values (50.76 ± 31.52 mg MDA. kg^{-1}). The shelf life recommended for silver carp was set at three months.

Key words: fish, storage, rancidity, shelf life

THE EFFECT OF THE ABATTOIR ON BEEF CARCASS CLASSIFICATION RESULTS

Maja PREVOLNIK¹, Manca KNAP², Andreja ŽABJEK², Marjeta ČANDEK-POTOKAR*^{1,2}

¹ Maribor University, Faculty of agriculture and life sciences; ² Agricultural institute of Slovenia

Corresponding author: **Marjeta ČANDEK-POTOKAR**, +38612805124; +3862805255; meta.candek-potokar@kis.si

The aim of the present study was to test a possible way of monitoring cattle carcass classification using a statistical approach. For that purpose the analysis of covariance (ANCOVA by SAS) was used with the fixed effect of the abattoir, carcass weight (as a covariate) and their interaction. The analysis was based on the relationship between carcass weight and conformation or fatness grades. We tested if the regression lines of individual abattoirs differ from the average. The analysis comprised data for young bulls of Simmental breed slaughtered in Slovenia in the period from 2007 to 2010 (52,624 records). Results showed that in many abattoirs the assessment of conformation and fatness deviates significantly from the average, *i.e.* regression lines for several abattoirs differ significantly from the average (population) line. Differences were more important for the conformation than fatness. Overall, the statistical process control using the analysis of covariance can be used for additional monitoring of cattle carcass classification.

Key words: cattle, carcass classification, uncertainty, abattoir effect, statistical control

THE INFLUENCE OF ZINC IN NUTRITION ON MEAT QUALITY OF YOUNG GOATS

Alena SALÁKOVÁ*¹, Alena PECHOVÁ², Olga JOKVEROVÁ²,
Hana BUCHTOVÁ¹, Ľubica MIŠUROVÁ², Leoš PAVLATA²

¹ Department of Meat Hygiene and Technology, University of Veterinary and Pharmaceutical Sciences Brno; ² Ruminant and Swine Clinic, University of Veterinary and Pharmaceutical Sciences Brno

Corresponding author: Alena SALÁKOVÁ, +420541562749; +420541321230; salakovaa@vfu.cz

A total of 22 young goats were used to assess the effect of two organic zinc sources, i.e. Zn lactate and Zn chelate, compared with Zn oxide and a control treatment without Zn supplementation on meat quality and zinc concentration in muscle. Muscle pH and colour (L^* – lightness, a^* – redness, b^* – yellowness) were determined in the *triceps brachii* muscles, immediately after slaughter and chilling (24 h). Zn content, chemical composition (dry matter, fat, protein and collagen content), drip losses, cook losses, hardness, cohesiveness, pH (48 h) and colour (48 h) were determined. We did not find statistical significant differences in meat quality between treatments. Significant difference was found in concentration of Zn only between control and group receiving Zn oxide ($P < 0.05$).

Key words: organic Zn, inorganic Zn, meat colour, chemical analysis, goats

FATTENING ABILITY, CARCASS AND MEAT QUALITY OF HEAVY TSIGAI LAMBS

Peter POLAK, Ján TOMKA, Emil KRUPA, Kvetoslav ZAUJEC,
Zuzana KRUPOVÁ, Marta ORAVCOVÁ and Ján HUBA

Animal Production Research Centre Nitra, Slovak Republic

Corresponding author: Peter POLÁK, Phone: +421376546428; fax: +421376546361;
e-mail: polak@cvzv.sk

The aim of the investigation was to analyse fattening ability, carcass and consumer meat quality from purebred Tsigai heavy lambs produced by sucking their mothers and natural grazing. Carcass and meat quality characteristics of 20 heavy lambs of Tsigai sheep were obtained at the average age of 137 days. Samples of *Musculus longissimus thoracis et lumborum* were taken for physico-chemical analysis (proteins, fat, total water content) and consumer meat quality (pH, water holding capacity, electro conductivity, colour and shear force) 48 hours after slaughter. Apparatuses Nicolet 6700 Spectrometer, Infracon 1265, pH meter Toledo and MiniScan XE plus or Spectrometer CM 2600 were used for analysis. Seven days after the slaughter, the grilling losses and shear force of grilled meat were obtained. Relatively high variability, more than 10%, were found for dressing percentage, weight of carcass, weight of meat in carcass, weight of valuable cuts in carcass, average daily gain and lean meat production per day. The highest variability was found for fat proportion in carcass. Despite of limited number of analysed animals in this preliminary study, the findings indicate that dual purpose breed Tsigai in ewe – lamb production system is able to produce heavy lambs with good meat quality. Results also showed that there is high variability within group of purebred Tsigai animals.

Key words: sheep production, heavy lambs, Tsigai, meat quality, shear force

VARIATION IN NITROGEN COMPONENTS OF SHEEP MILK IN DALMATIAN HINTERLAND

Sinisa MATUTINOVIC¹, Kresimir SALAJPAL^{2,*}, Samir KALIT³

¹ Industry of dairy products "MILS"; ^{2,*} Department of Animal Science, Faculty of Agriculture, University of Zagreb; ³ Department of Dairy Science, Faculty of Agriculture, University of Zagreb

Corresponding author: **Kresimir SALAJPAL** Tel.: +385 1 2394 038, fax: +385 1 2393 947; ksalajpal@agr.hr

The objective of this study was to evaluate the seasonal variation in urea concentration and other nitrogen components of sheep milk in Dalmatian hinterland over the period of two years. The study was performed on three family farms with 150 to 300 sheep per farm using semi-extensive farming management. Bulk-tank milk samples were taken during whole milking period (from March to July or August) and were analyzed for milk fat, protein, casein, non protein nitrogen (NPN) and urea content. Flock had significant effect on milk fat, protein and NPN content ($P < 0.05$) and tended to affect casein content ($P < 0.10$). Significant effect of the year was observed on urea and NPN content ($P < 0.05$). In addition, season had significant effect on all analyzed milk parameters ($P < 0.01$) except the NPN. Variations on nitrogen components of sheep milk in Dalmatian hinterland have been significant due to the fact that the semi-extensive farming systems could be strongly affected by climate and local environmental and feeding conditions.

Key words: Sheep milk, nitrogen components, Dalmatian hinterland

THE EFFECT OF OMEGA-3 FATTY ACID ENRICHMENT ON THE QUALITY CHARACTERISTICS OF A SPECIAL HUNGARIAN COLD-CUT (PÁRIZSI)

Judit BELOVAI¹, Diána BÁNÁTI*², Róbert ROMVÁRI¹, András SZABÓ¹

¹Kaposvár University Faculty of Animal Science; ²Central Food Research Institute Budapest

Corresponding author: **Judit BELOVAI**, +3682505800; 357; belovai.judit@ke.hu

Nowadays a new value added marketing trend is increasing omega-3 fatty acid (FA) content in food products – pertaining the functional food group – aiming to improve cardiovascular health status. Omega-3 FA enrichment is mainly based on flax seed and canola (or their oils) addition, being rich sources of alpha-linolenic acid (ALA). The aim of this study was to enrich the Hungarian special cold cut (párizsi) with omega-3 Fas (3, 6, 9 % soya or linseed oil addition) to reach a more favourable FA composition, and to determine the consequent changes in product parameters (colour, rheology). The total lipid content was extracted according to Folch et al. (1957) and analysed by GC. The texture profile analysis (TPA) was performed with a Zwick Z005 equipment and two values – hardness and shearing force- were applied to describe the texture. The surface colour was measured with a tristimulus colorimeter (b* - yellowness, a* - redness and L - brightness). Increasing oil concentration in the samples reduced the n6/n3 FA ratio all cases, mainly with flaxseed enriched samples, whereby in 9% concentration the optimal ratio (~ 4) has been reached. Other handling effects (cooking and storage) did not markedly modify the fatty acid profile. TPA parameters of párizsi were affected by the proportions of enrichment and by chilled storage. The oil addition decreased hardness and shearing force. Párizsi samples were harder at the end of storage irrespective of the formulations. Lightness (L) values for samples were affected by the extent of enrichment and by storage time. These factors slightly influenced redness and yellowness. In summary, omega-3 FA rich vegetable oil enrichment markedly improves the FA profile of samples, by not always advantageously altering texture and surface color.

Key words: Meat product, Omega-3 Fatty acids, Functional food, Soya oil, Linseed oil

EFFECT OF BELGIAN BLUE AND PIEDMONTESE SIRES ON CARCASS AND MEAT QUALITY TRAITS OF CROSSBREED HEIFERS

Ilario BAZZOLI*, Mauro PENASA, Giovanni BITTANTE,
Massimo DE MARCHI

Department of Animal Science, University of Padova, Viale
dell'Università 16, 35020 Legnaro (PD), Italy

Corresponding author: **Ilario BAZZOLI** +390498272614;
ilario.bazzoli@studenti.unipd.it

The aim of this study was to estimate the effect of two beef breeds (Belgian Blue and Piedmontese) on carcass weight (kg) and value (Euro), and meat quality traits of crossbreed heifers. Sixteen animals progeny of Belgian Blue and 8 of Piedmontese sires were raised in one commercial farm. Heifers were fed the same diet and slaughtered in three different dates. The pH, cooking losses (%), Warner-Bratzler shear force (N), lightness (L*), redness (a*), and yellowness (b*) were assessed on *Longissimus thoracis* muscle after 10 days from slaughtering. In addition, saturation index (SI) and hue angle (H) were calculated using a* and b* values. An analysis of variance was performed on the studied traits including the fixed effects of slaughtering date (3 levels) and sire breed (Belgian Blue and Piedmontese). The effect of slaughtering date was significant in explaining the variability of carcass value, pH, a*, b* and SI, whereas the effect of sire breed was significant only for carcass weight and value. No differences were detected between the progeny of the two beef breeds for meat quality traits, whereas carcass weight and value (\pm SE) were higher for Belgian Blue-sired (336 ± 5 kg and $1,907 \pm 30$ Euro/carcass, respectively) than Piedmontese-sired heifers (300 ± 7 kg and $1,707 \pm 41$ Euro/carcass, respectively). Based on these results, the use of Belgian Blue seems to be preferable instead of Piedmontese sires.

Key words: Beef quality, Belgian Blue, Crossbreeding, Heifer, Piedmontese

WEIGHT LOSS IN THE PROCESSING OF DRY-CURED MUTTON: EFFECT OF AGE, GENDER AND PROCESSING TECHNOLOGY

Marina KRVAVICA*¹, Boro MIOČ², Miljenko KONJAČIĆ²,
Emilija FRIGANOVIĆ¹, Amir GANIĆ³, Andrijana KEGALJ¹

¹ University of Applied Sciences "Marko Marulić" in Knin, ² University of Zagreb Faculty of Agriculture, ³ University of Sarajevo Faculty of Agriculture and Food Sciences

Corresponding author: **Marina KRVAVICA**; +38522664458;
mkrvavica@veleknin.hr

In order to determine the effect of age, gender and castration, as well as ripening duration and anatomical position on the weight loss (WL) during processing of castradina production (an indigenous Dalmatian dry-cured mutton), 60 ewes (E) of three age groups (up to 2.5 yr, from 3 to 5 yr, more than 5.5 yr) and 40 males (wethers - W and rams - R), 20 in each group, were slaughtered. After cutting the carcasses, whole legs, shoulders and rest parts called "kora" were subjected to processing (salting, drying, ripening) during which the WL was determined. Since the total WL of the E₃₋₅ was the lowest (27.72%) and total WL of the E_{2,5} and E_{5,5} were the similar (30.71% and 30.48%, respectively), despite significant differences of these three age groups of E-castradina, one cannot conclude that age of the sheep affects the WL of the E-castradina. The procedure of the castration had significant effect on the total WL, since the total WL of the R-castradina was the highest (38.76%) compared to the total WL of W (29.92%) and E_{2,5} and E_{5,5}, which were the similar (except E_{3,5} which was lower than W). The highest total WL was found for the shoulder (35.05%), and the lowest was found for the whole leg (27.26%), while the one of the "kora" was in between (31.95%), whereby the differences among all three groups were significant ($p < 0.001$ and $p < 0.05$, respectively). Considering the thickest muscle of the whole leg and much shorter ripening period of the "kora" (despite the larger surface area and smaller thickness) these values of the total WL are logical.

Key words: weight loss, dry-cured mutton, castradina, age, gender

4. BREEDING AND GENETICS

4.1. ORAL PRESENTATIONS I

Chairs: I. Nagy, B. Fuerst-Waltl

4.2. ORAL PRESENTATIONS II

Chairs: R. Finocchiaro, V. Čubrić Čurik

4.3. ORAL PRESENTATIONS III

Chairs: Š. Malovrh, G. Mészáros

4.4. ORAL PRESENTATIONS IV

Chairs: G. Gorjanc, A. Cecchinato

EXPLORING DIFFERENT MODEL STRUCTURES FOR THE GENETIC EVALUATION OF DAIRY BULL FERTILITY

Francesco TIEZZI¹, Mauro PENASA¹, Christian MALTECCA²,
Alessio CECCHINATO¹, Giovanni BITTANTE¹

¹ *Department of Animal Science, University of Padova;* ² *Department of Animal Science, North Carolina State University*

Corresponding author: Francesco TIEZZI, +39 049 827 2614; +39 049 827 2633; francesco.tiezzi@unipd.it

The aim of study was to investigate different models for the evaluation of dairy bulls for male fertility. A dataset containing single insemination records performed on Brown Swiss cows and heifers reared in Eastern Italian Alps was used. The outcome variable (successful/ unsuccessful) was analyzed as binary trait. In the first step raw conception rate was computed for each service sire, as the mean of the outcome of all his insemination events. In the second step Bayesian threshold sire models were implemented via Gibbs sampling. Different models increasing in complexity were fitted, in order to obtain variance components and sire solution estimates. Results showed that genetic variance for direct effect(s) on conception rate is low (repeatability=0.014; heritability=0.009-0.073) and raw conception rate is poorly related to solutions from prediction models. If the service sire is a diagonal effect, rank correlations with raw conception rate are about 0.81-0.84, while those decrease to 0.74-0.78 if service sires are related by a relationship matrix, and is null (-0.01-0.06) if is the sire of the service sire to account for the direct genetic effect. Service sire fertility (sire of service sire effect) has been proven to be a different trait to embryo survival (service sire effect) giving rank correlation of 0.11-0.24. In conclusion phenotypic and genetic differences in male fertility among the service sires exist, and should be monitored thought a reliable evaluation system.

Key words: Brown Swiss, bull fertility, threshold model, heritability

ESTIMATION OF VARIANCE COMPONENTS FOR LITTER SIZE IN THE FIRST AND LATER PARITIES IN IMPROVED JEZERSKO-SOLCAVA SHEEP

Dubravko ŠKORPUT¹, Ante KASAP¹, Gregor GORJANC*²

¹University of Zagreb, Faculty of Agriculture, Animal Science Department, ²University of Ljubljana, Biotechnical Faculty, Animal Science Department

Corresponding author: **Gregor GORJANC**, +38613203861; gregor.gorjanc@bf.uni-lj.si

Aim of this study was to estimate variance components for litter size in Improved Jezersko-Solcava sheep. Analysis involved 66,082 records from 12,969 animals, for the number of lambs born in all parities (BA), the first parity (B1), and later parities (B2+). Fixed part of model contained the effects of season and age at lambing within parity. Random part of model contained the effects of herd, permanent effect (for repeatability models), and additive genetic effect. Variance components were estimated using the restricted maximum likelihood method. The average number of lambs born was 1.36 in the first parity, while the average in later parities was 1.59 leading also to about 20% higher variance. Several models were tested in order to accommodate markedly different variability in litter size between the first and later parities: single trait model (for BA, B1, and B2+), two-trait model (for B1 and B2+), and single trait model with heterogeneous residual variance (for BA). Comparison of variance components between models showed largest differences for the residual variance, resulting in parsimonious fit for a single trait model for BA with heterogeneous residual variance. Correlations among breeding values from different models were high and showed remarkable performance of the standard single trait repeatability model for BA.

Key words: sheep, litter size, variance components, heterogeneity

LAMBING INTERVAL IN JEZERSKO-SOLČAVA AND IMPROVED JEZERSKO-SOLČAVA BREED

Andreja KOMPREJ¹, Gregor GORJANC¹, Dragomir KOMPAN¹

¹ University in Ljubljana, Biotechnical Faculty, Department of Animal Science

Corresponding author: Andreja KOMPREJ, +38613203924; andreja.komprej@bf.uni-lj.si

The effects on lambing interval (LI) in Improved Jezersko-Solčava (IJS) breed were studied. Due to the reason that IJS breed originates from Jezersko-Solčava (JS) breed, both breeds were included into the analysis. The data were obtained from the Republic Data Base for Selection of Small Ruminants, between 1993 and 2008. The analysis included 66,755 lambings from 280 breeders. The statistical model included breed, parity, litter size at previous lambing, month of the previous lambing, year of the previous lambing, breed of the ram, geographical location of the flock, interaction between month of the previous lambing and breed of the ram, interaction between parity and month of the previous lambing, interaction between breed of the ewe and month of the previous lambing, and interaction between breed of the ewe and litter size at previous lambing as fixed effects. Flock and interaction between year of the previous lambing and flock were treated randomly. Month of the previous lambing affects LI, which is gradually shortening from February to August, and prolonging from August to February. Number of live born lambs was significantly affected by the LI. LI between the first and the second parity and between the second and the third parity was longer than between higher parities. From 1993 to 1999, the LI was decreasing, and increasing thereafter. Ewes mated with JS ram had longer lambing interval than ewes mated with IJS ram. Among all observed effects, flock affected LI the most.

Key words: sheep, improved Jezersko-Solčava breed, reproduction, lambing interval

**GENETIC AND PHENOTYPIC PARAMETERS FOR
REPRODUCTION TRAITS OF LANDRACE SOWS IN
LATVIA**

Ieva ZIEDINA¹, Daina JONKUS¹, Liga PAURA*¹

¹ *Latvia University of Agriculture*

Corresponding author: Liga PAURA +3713005707; liga.paura@llu.lv

The aim of this study was to investigate reproduction performance in the 1st and 2nd parity of Latvian Landrace sows, to estimate genetic parameters for reproduction traits, and to determine their genetic correlations with age at the first farrowing (AFF) and weaning to insemination interval (WII) in the Latvian Landrace swine population. Data from 2054 of the 1st parity and 1416 of the 2nd parity sows were collected from 2005 till 2010 and were included in the analysis. Four reproduction traits in the study were analysed: number of piglets born alive (NBA), number of piglets dead (ND), number of piglets weaned per litter (NW) and 21-day litter weight (W21). Genetic parameters were estimated with multi traits animal model using REML procedure. The heritability estimates in the first parity were 0.07, 0.16, 0.36, 0.01 and 0.32 for NBA, NW, W21, AFF and WII, respectively. Between AFF and sows reproduction traits in the first and the second parity unfavourable genetic correlations were found in the present data set. Moderate negative genetic correlation between WII and sows reproduction traits was observed.

Key words: pigs, reproduction, genetic parameters

MORPHOMETRICAL ANALYSIS OF REPRODUCTION TRAITS FOR THE WILD BOAR (*Sus scrofa* L.) IN CROATIA

Nikica ŠPREM¹, Marina PIRIA¹, Tihomir FLORIJAČIĆ³, Boris ANTUNOVIĆ³, Tomislav DUMIĆ³, Hrvoje GUTZMIRTL⁴, Tomislav TREER¹, Ino CURIK²

¹University of Zagreb, Faculty of Agriculture, Department of Fisheries, Beekeeping, Game Management and Special Zoology,; ²University of Zagreb, Faculty of Agriculture, Department of Animal Science; ³University of J. J. Strossmayer in Osijek, Faculty of Agriculture, Chair for Wildlife, Fishery and Beekeeping; ⁴Center for Livestock Improvement Antunovac

Corresponding author: **Nikica ŠPREM**, tel.+385 1 2393 860, fax. +385 1 2315 300, nsprem@agr.hr

The wild boar (*Sus scrofa* L.) is native game in Croatia, whose population have tendency of increasing as well throughout the Europe. The wild boar is a natural inhabitant of Europe, Asia, and North Africa and is phylogenetically the ancestor of the domestic pig. Because of its phylogenetic and economic importance, this species is an interesting model for studying testis function. Therefore, the present study was performed to investigate the testis morphometry, and gonadosomatic index (GSI) for 77 individuals. The mean live body weight was 75.03 kg, testis weight was 0.355 kg and with a gonadosomatic index (GSI) of approximately 0.40%. The mean circumference for the left and right testes were not significant, but a significant and positive correlation was observed between testis weight and body weight ($r = 0.88$, $p < 0.05$). A high reproductive contribution of juveniles is a likely consequence of a high hunting pressure rather than a species specific life history pattern characterizing wild boar. Generally, beside female seasonal reproductive activity knowledge of male reproduction cycle in wild boar is very important for established better management of free-ranging population.

Key words: Croatia, GSI, testis circumference, wild boar

MILK YIELD TRAITS, SOMATIC CELL SCORE, MILKING TIME AND AGE AT CALVING OF PURE HOLSTEIN VERSUS CROSSBRED COWS

Francesca MALCHIODI*, Mauro PENASA, Francesco TIEZZI,
Giovanni BITTANTE

Department of Animal Science, University of Padova

*Corresponding author: Francesca MALCHIODI, +390498272614;
francesca.malchiodi@studenti.unipd.it*

Pure Holstein (HO, n=430), crosses between Swedish Red and HO (SRxHO, n=41), Montbeliarde and HO (MOxHO, n=18), and MO and SRxHO (MOxSH, n=53) were compared for milk, fat and protein yield, fat and protein percentage, somatic cell count (SCC), milking time (MT), and age at first and second calving. A total of 180,933 test-day information for milk yield and MT, and 5,249 for fat and protein percentage and SCC were recorded on first and second parity cows milked in one herd of Cremona province (northern Italy). Somatic cell count and MT were log-transformed to somatic cells score (SCS) and LnMT, respectively, before statistical investigation. Production traits, LnMT and SCS were analyzed through a mixed model that included fixed effects of test-day, parity, days in milk (DIM), genotype and interaction between parity and genotype, and the random effects of cow nested within genotype and residual, whereas the model for age at calving included year and month of calving and genotype as fixed effects, and residual as random. MOxHO and pure HO cows differed only for age at second calving (70 d higher for purebreds; $P<0.05$). Holsteins produced more milk (+2.86 kg/d; $P<0.01$) and protein yield (+0.05 kg/d; $P<0.05$) than SRxHO crossbreds, but lower protein percentage (-0.09%; $P<0.01$), and age at second calving was 44 d ($P<0.01$) higher than SRxHO. Also, HO produced more milk and fat than MOxSH cows (+1.61 and +0.08 kg/d, respectively; $P<0.05$), but lower protein percentage (-0.11%; $P<0.001$), and calved later, both at first and second calving (+24 and +43 d, respectively; $P<0.05$). Results indicated that crossbred cows can compete with the cosmopolitan breed for several traits.

Key words: age at calving, crossbreeding, dairy cattle, milk production, milking time

NEW RESEARCH STRATEGIES IN LACTATION BIOLOGY

Jernej OGOREVC¹, Sonja PRPAR¹, Tanja KUNEJ¹, Črt GORUP²,
Eva ČEH¹, Juan F. MEDRANO³, Peter DOVČ^{1*}

¹University of Ljubljana, Biotechnical Faculty, Department of Animal Science;

²University of Ljubljana, Faculty of Computer Science and Informatics; ³University of California, Davis, Department of Animal Science

Corresponding author: **Peter DOVČ**, +386013203836; peter.dovc@bf.uni-lj.si

Different approaches have been used to study milk related traits in farm animals, reaching from statistical dissection of phenotypic variation to the search of candidate genes with major phenotypic effects. The aim of this study was to develop a new research tool devoted to *in vitro* studies of physiological pathways responsible for mammary gland development, lactation, remodeling and immune response and in addition a user friendly map based bioinformatics tool for integration of different types of data. We established goat mammary gland derived primary epithelial cell line with predominantly epithelial morphology, responsive to lactogenic hormones and regeneration potential in heterologous mouse system. The response of primary epithelial cells to pathogenic bacterium *Mycoplasma agalactiae* was studied using RNA sequencing approach and 1553 differentially expressed genes were detected 24 h post infection. The majority of differentially expressed genes belonged to cell cycle chemokines, pro-inflammatory cytokines and genes involved in lipid metabolism. Bioinformatic analysis of 359 putative target sites for mammary gland expressed miRNAs revealed polymorphic miRNA target sites for bta-miR-199b, -199a-5p, and -361 in the *IL1B* gene and for -miR-126 in the *CYP11B1* gene. Graphical integration of different types of data to DairyVis platform allowed identification of genomic regions with higher number of potential functional elements that deserve further experimental analysis. The newly developed MEC line and integration of bioinformatics tools into DairyVis data base represent a promising methodological support for further research in the field of lactation biology.

Key words: lactation, mammary gland biology, QTL, RNAi, RNA sequencing, stem cell, visualisation of genomic data

PARTITIONING OF GENETIC TRENDS BY ORIGIN IN CROATIAN SIMMENTAL CATTLE

Marija ŠPEHAR*¹, Zdenko IVKIĆ¹, Vesna BULIĆ¹, Zdravko BARAČ¹, Gregor GORJANC²

¹Croatian Agricultural Agency; ²University of Ljubljana, Biotechnical Faculty, Animal Science Department

Corresponding author: **Marija ŠPEHAR**, +38513903176; mspehar@hpa.hr

The objective of this study was to partition genetic trend for milk (protein yield) and meat (net daily gain) traits by the origin of selection in Croatian Simmental cattle. In order to evaluate overall genetic trend, breeding values were averaged by the year of birth and origin. Origin was defined as a country where animal was initially registered. Overall genetic trend for protein yield was positive. The relative effect of three origins on the overall genetic trend for protein yield was 43.5% for Germany, 33.9% for Croatia, and 22.1% for Austria at the end of analysed period. Genetic trend for net daily gain was also positive. The Croatian and German partitions had large contribution to the overall genetic trend, while small partition was attributed to the Austrian origin. At the end of analysed period, the relative effect of these three origins on the overall genetic trend for net daily gain was 57.0% for Croatia, 38.5% for Germany, and 4.5% for Austria. Selection work originated from Austria, Croatia, and Germany had effect on genetic trend in Croatia. Other origins did not contribute notably to the overall genetic trend of both traits.

Key words: genetic trends, origin, protein yield, net daily gain, Simmental cattle

GENETIC PARAMETERS AND INBREEDING DEPRESSION OF LITTER WEIGHT IN PANNON WHITE RABBITS

István NAGY¹, János FARKAS¹, Szilvia ONIKA-SZVATH¹, István RADNAI¹, Zsolt SZENDRŐ¹

¹University of Kaposvár

Corresponding author: **István NAGY** +36-82-505-800; +36-82-320-167;
nagy.istvan@ke.hu

Genetic parameters and inbreeding depression were estimated for litter weight at day 21 of a synthetic Pannon White rabbit population selected as a closed population since 1992. The data file consisted of 15652 kindling records of 3711 rabbit does (mated to 933 bucks) collected between 1992 and 2009. The total number of animals in the pedigree file was 4804. REML and BLUP procedures were applied using repeatability animal model (VCE and PEST software). The estimated narrow sense heritability for litter weight was low (0.08 ± 0.01). The estimated permanent environmental effects showed higher relative importance compared to the additive genetic effects (0.13 ± 0.01). Analyzing the inbreeding depression simultaneously for all parities, increasing the inbreeding coefficient by 10% had small positive effect on litter weight (0.028 kg) but the estimate was not significant ($p=0.30$). When the inbreeding depression was estimated by parities small depressions (-0.023, -0.045 and -0.021 kg) were found for the 2-4th parity groups but the estimates were not significant ($p=0.59$, 0.23 and 0.61, respectively). On the contrary a significant positive effect was observed for the 1st parity (0.198 kg; $p=0.01$). The small positive estimate estimated at the 5th parity (0.033 kg) was not significant ($p=0.39$).

Key words: rabbit, genetic parameter, inbreeding depression, litter weight

INBREEDING AND ITS EFFECT ON PERFORMANCE TRAITS IN AUSTRIAN MEAT SHEEP

Lina MAXIMINI*, Alexander MANRIQUE-GOMEZ, Birgit FUERST-WALTL

University of Natural Resources and Life Sciences, Department of Sustainable Agricultural Systems, Division of Livestock Science, Vienna

Corresponding author: Lina MAXIMINI +431476543252; Fax +431476543254; lina.maximini@boku.ac.at

The aim of this study was to evaluate the level of inbreeding of meat performance tested herd book sheep in Austria and to evaluate the effect of individual inbreeding on growth and CT (computer tomography) scan carcass traits. Performance data (13,614 records, five breeds: Merinoland, Suffolk, Texel, German Blackheaded Meat sheep, Jura) were collected in the years 2000-2010. The traits analysed were live weight and average daily gain, as well as traits of body frame, back fat and eye muscle area, all measured on live animals with CT. Inbreeding coefficients (F) were calculated with the software PEDIG. F was nested within breed tested in a mixed model using ASReml. Levels of inbreeding were low with \bar{F} of 1.5-3.1%. Only few traits were significantly affected by inbreeding. Both positive and negative effects were found. The effects were small, most often nonlinear and vary across breeds. Inbreeding and its effects on performance traits do not seem to be an issue in Austrian meat sheep populations at the moment. However, monitoring and further analyses are recommended.

Key words: carcass traits, growth traits, CT scanning, across breed analysis, inbreeding depression

MITOCHONDRIAL DNA DIVERSITY IN WILD BOARS FROM THE ISTRIA AND CRES ISLAND

Vlatka CUBRIC CURIK*¹, Marina ATLIJA¹, Nikica ŠPREM², Ino
CURIK¹

¹ *Department of Animal Breeding, Faculty of Agriculture, University of Zagreb,* ²
Department for Fisheries, Beekeeping and Special Zoology, Faculty of Agriculture,
University of Zagreb

Corresponding author: Vlatka CUBRIC CURIK, +38512394008; +3852393947;
vcubric@agr.hr

The aim of study was to analyze the nucleotide diversity of mitochondrial DNA control region (CR-mtDNA) of 33 wild boars hunted in Istria and Cres Island (Croatia) in order to prove the presence of clade E2 haplotypes outside the Italian Peninsula and Sardinia. Outside of Italy haplotypes from clade E2 have been found only in Istria (Pupcina Cave) on archaeological samples dating to 9000 years BC. Among 21 haplotypes found on a 428-bp sequence fragment representing European wild boars, with 227 sequences additionally retrieved from the GeneBank, our wild boars were assigned in two haplotypes classified in clade E1. Two wild boars, from Oprtalj and Grožnjan, were distributed in the haplotype H2 while the other 31 samples were distributed in the haplotype H6. On the analyzed fragment, observed haplotypes were two (T→C at 15714 and 15758) and one (T→C at 15758) transversions remote from the reference sequence reported in the GenBank under accession number AJ002189 (Ursing and Arnason, 1998). The H2 and H6 haplotypes were both previously found in European wild boars, most frequently in haplotypes from Portugal and Spain. In conclusion, the results obtained were concordant to the hypothesis that clade E2 haplotypes are indigenous to Italy and Sardinia. According to the maternal origin, the Istrian and Cres Island wild boars are close to the Gorizia region (north-east Italy) population as well as to wild boars from Portugal and Spain.

Key words: wild boar, mitochondrial DNA, nucleotide diversity, Istria region, Cres island

**USE OF MITOCHONDRIAL DNA ANALYSES IN
VERIFICATION OF THE
LIPIZZAN HORSE PEDIGREE**

Mato ČAČIĆ¹, Vlatka CUBRIC CURIK², Mirjana BABAN³,
Zdravko BARAČ¹, Ino CURIK²

¹ Croatian Agriculture Agency; ² University of Zagreb, Faculty of Agriculture; ³
University of J. J. Strossmayer in Osijek, Faculty of Agriculture

Corresponding author: **Mato ČAČIĆ** +38513903187; mcacic@hpa.hr

The Lipizzan horse, established in 1580 in Lipica, is one of the most famous horse breed in the world. To verify the authenticity of maternal lineages in Lipizzan horses we analyzed maternal segregation of the nucleotide sequence of the mitochondrial control region (D-loop mtDNA) (nt 15476 – 15834) through the pedigree. The analyses were done for 258 Lipizzan horses sampled mainly in Croatia, State stud Lipik (40), State stud Đakovo (59) and private farms (129) as well as in Bosnia and Herzegovina, State stud Vučijak (19). Out of 24 analyzed mare lines we have found 23 different haplotypes. On a very long pedigree, tracing up to 36 generations, we found inconsistency (18.2%) in the maternal segregation. In several cases we were able to reconstruct the history and origin of the pedigree errors. Here, for populations with complex pedigree structure, we demonstrated the usefulness of the joint mtDNA and pedigree segregation analyses in tracing pedigree errors and maintenance of reliable herd book identification.

Key words: Lipizzan, mitochondrial DNA, pedigree error, maternal lineage

ANALYSIS OF THE RELATIONSHIPS BETWEEN TYPE TRAITS AND LONGEVITY IN CROATIAN SIMMENTAL CATTLE USING SURVIVAL ANALYSIS

Sonja JOVANOVAČ*¹, Nikola RAGUŽ¹

¹*Josip Juraj Strossmayer University of Osijek, Faculty of Agriculture*

Corresponding author: Sonja JOVANOVAČ, +38531224222; jsonja@pfos.hr

Survival analysis with a Weibull proportional hazards model was used to evaluate the effect of linear type traits on the longevity in Croatian Simmental cattle. The data set consisted of 8,212 registered Simmental cows that first calved from 1997 to 2008. Longevity was defined as the number of days between first calving to culling or censoring. Cows alive at the end of the study (13.6%) were treated as right censored. Type information consisted of 19 linear type traits (with a nine-point scoring range) scored in the first lactation. Linear type traits were classified into four groups: muscularity, size traits, form traits and udder traits. The Weibull model included the time-independent effects of age at first calving, classifier, region and each type trait. The results showed a significant effect of 12 type traits on longevity. Among the form traits, low angled pasterns and extremely straight rear leg side view showed almost 2.0 times higher culling risks than normal posture. Cows with higher scores for the muscularity were at higher culling risk levels compared to lower scores. In the group of size traits, only rump height and body depth had significant impact on longevity. Lower scores for fore udder length were associated with lower risk of culling. In contrary, cows with lower scores for udder depth, suspensory ligament, rear udder length and teats thickness had higher probability of culling than the animals with higher scores.

Key words: Simmental cows, longevity, linear type traits, survival analysis

GENETIC PARAMETERS OF GROWTH TRAITS FROM A JOINT EVALUATION OF PUREBRED AND CROSSBRED PIGS

Henrietta NAGYNÉ KISZLINGER^{*}, János FARKAS¹, György KÖVÉR¹, Szilvia ONIKA-SZVATH¹, István NAGY¹

¹*University of Kaposvár*

Corresponding author: Henrietta NAGYNÉ KISZLINGER, +36-82-505-800; Fax: +36-82-320-167; kiszlinger.henrietta@ke.hu

Authors analyzed average daily gain and lean meat percentage of the Pietrain (Pi), Duroc (Du) and their cross (PixDu); Pietrain (Pi) and Hampshire (Ha) and the cross (PixHa) using the national database for the period of 1997-2010. The heritability estimates for average daily gain (0.20 ± 0.02 , 0.24 ± 0.02 , 0.25 ± 0.03 , 0.37 ± 0.06 , 0.37 ± 0.02 for Pi, Du, PixDu, Ha, PixHa, respectively); and lean meat percentage (0.17 ± 0.02 , 0.15 ± 0.02 , 0.13 ± 0.02 , 0.22 ± 0.06 , 0.20 ± 0.02 for Pi, Du, PixDu, Ha, PixHa, respectively) were low. Genetic correlation between the purebreds and the crossbreds ranged from moderately high to high for average daily gain (0.93 ± 0.15 , 0.85 ± 0.12 , 0.56 ± 0.14 , 0.75 ± 0.12) and from moderate to moderately high for lean meat percentage (0.65 ± 0.16 , 0.56 ± 0.16 , -0.38 ± 0.17 , 0.48 ± 0.20) for Pi – PixDu, Du – PixDu, Ha – PixHa, Pi – PixHa, respectively. Based on the results the selection of the purebred parents for crossbred pigs can be based on the performance of their purebred breeding values of average daily gain. On the contrary for lean meat percentage the crossbred breeding values of the purebred pigs can also be used to select the best purebred pigs for crossing.

Key words: pig, genetic correlation, daily gain, lean meat percent, purebred, crossbred

ECONOMIC IMPORTANCE OF THE TRAITS FOR SLOVAK PINZGAU BREED REARED IN DAIRY AND COW-CALF SYSTEM

Emil KRUPA*, Zuzana KRUPOVÁ, Marta ORAVCOVÁ, Peter POLÁK, Ján TOMKA

Animal Production Research Centre Nitra

Corresponding author: Emil KRUPA, +421376546328, krupa@cvzv.sk

The bio-economic approach was used to calculate economic weights for twelve production (dairy and growth), functional and carcass traits of Slovak Pinzgau cattle raised in dairy (A) and cow-calf (B) system. The breeding heifers for own herd replacement with ten reproduction cycles at maximum was produced. The sale of surplus male and female calves was assumed after finishing of weaning period in both systems. Milk production is with quota limited in Slovakia, but the quotas limits aren't filling up if the whole dairy population is taken into account. In the system A, the base price per milk value was corrected according to the fat and protein content and somatic cells count. The marginal economic weights were calculated as the numeric derivation of the profit function. Marginal values were standardized (multiplied by the genetic standard deviation of the appropriate trait) and expressed as relative values (percentage proportion). The marginal economic weight for milk yield (+0.20 €) and for dressing percentage (+0.39 €) were the lowest in both systems. The highest marginal importance was found for production lifetime of cows in system A (+69.26 € per year and cow), and in system B (+52.55 € per year and cow), respectively. Functional traits achieved the highest marginal values in both systems. But the relative economic values for the functional traits complex represent only 37.04% in system A, and 73.52% in system B, respectively. The proportion of functional, production and carcass traits complexes was 37.04 : 62.73 : 0.23 in system A, and 73.52 : 26.07 : 0.41 in system B. The highest relative economic importance was observed for the 305 d milk production (37.70%) in system A and yearling weight (25.35%) in system B, respectively. Subsidies in the calculations were of positive effect on the profitability in the system B but it was not sufficient for positive profitability in the system A. The system A achieves negative profitability irrespective on assigned subsidies. The system B has positive profitability after accounting subsidies.

Key words: economic weights, Pinzgau breed, dairy system, cow-calf system

GENETIC PARAMETERS OF CONFORMATION TRAITS IN BROWN, SIMMENTAL AND HOLSTEIN BREED CALVES IN SLOVENIA

Betka LOGAR¹, Miran ŠTEPEC², Klemen POTOČNIK²

¹ *Agricultural Institute of Slovenia, Animal Science Department,* ² *University of Ljubljana, Biotechnical Faculty, Zootechnical Department*

Corresponding author: Betka LOGAR+386 12805130; +38612805255;
betka.logar@kis.si

Conformation traits of Brown, Simmental and Holstein breed calves were studied to estimate the genetic and environmental parameters using data from two classification systems. Calves were classified in the period 2000 – 2010 between the age of one to 51 days. Beside the chest girth as a measurement in cm five traits were scored. At the beginning, the traits such as muscularity, form, body depth, body length and width were scored on the scale from 1 to 3 or 1 to 9 while in the year 2008 the system of classification changed to scores from 1 to 5 for all traits. Due to high variability of the data their thorough cleaning and homogenisation was required. Uni- and bivariate analyses using animal model methodology were performed. The effects of technician by year of classification, classification age class, birth season in months by years were treated as fixed and the herd by year of classification and additive genetic effect as random. Heritability estimates for data from the new classification system are rather higher (0.05-0.29) than those from the old system. Genetic correlations between estimates of two classification systems are very high, i. e. in a range from 0.74 to 0.97, which indicates a strong genetic relationship between the old and the new system of classification. The only exceptions were form and body depth in Simmental breed. In the chest girth the estimates of heritability from 0.16 to 0.27 were obtained.

Key words: cattle, conformation traits in calves, genetic parameters, classification systems

IMPROVING THE FINAL LIVEWEIGHT AND GROWING ABILITY OF TETRA-H A DUAL PURPOSE CHICKEN TYPE BY USING A NEW EXPERIMENTAL SIRE LINE

A. ALMASI¹, Z. SUTO¹, A. ORBAN², T. FULOP¹, P. O. KUSTOSNE¹,
G. MILISITS¹, P. HORN¹

¹Faculty of Animal Science, Kaposvár University, ²Bábolna Tetra Ltd, Uraiújfalu, Hungary

Corresponding author: Anita ALMASI, +3682505800, almasi.anita@ke.hu

Our study was carried out with the pure, crossed and reciprocal crossed offspring of TETRA-H hybrid, a coloured slow-growing broiler genotype which was developed in the 1980's by Bábolna TETRA Ltd. In this project the potential of a new, improved sire line was also investigated. Experiments were carried out in the Poultry Test Station of the Kaposvár University in 2008 - 2010. In the first stage, growing ability of TETRA-H and a commercial genotype (standard control=Shaver Redbro) had been compared. In stages two and three the **LL** line, which was previously used as sire line, the newly selected sire Line **EE**, and the offspring came from the combination of those lines have been centrally tested. A total number of 6453 birds were used. The following traits were investigated: live weight, body composition evaluated by CT, carcass yield, meat quality, etc. The positive impact of the newly developed sire line (**EE**) in their offspring was confirmed. Lower slaughter weight of the F₁ offspring has improved by 10.1-10.8%, making the newly developed hybrid highly competitive on the market. Furthermore, the crossing method was incompetent (**LL**♂x**EE**♀ or **EE**♂x**LL**♀) in the birds live weight and growing ability.

Key words: slow growing broiler, pure lines and crossed offspring, liveweight, body composition, meat quality

**CLUSTER ANALYSIS ON ACROSS COUNTRY GENETIC
CORRELATIONS FOR CONFORMATION TRAITS IN
HOLSTEIN CATTLE BREED**

Mara BATTAGIN^{*1}, Flavio FORABOSCO², Mauro PENASA¹,
Martino CASSANDRO¹

1 Department of Animal Science, Padua University; 2 Interbull Centre, Uppsala

*Corresponding author: Mara BATTAGIN +390498272779;
mara.battagin@studenti.unipd.it*

The aim of this paper is to investigate across country genetic correlations of conformation traits of 21 Holstein bulls' populations, using cluster analysis. Data consisted of across country genetic correlations of 18 conformation traits estimated by Interbull for the April 2011 routine genetic evaluation. For cluster analysis, the distance measure (d_{ij}) between countries i and j was calculated as $d_{ij}=1-rG_{ij}^2$, where rG_{ij} is the genetic correlation between countries i and j . Traits showed different mean distances with the lowest value for udder depth (0.062) and the highest for locomotion (0.441). For traits with similar definition further investigation is needed to understand differences within cluster. Also, more attention needs to be paid to countries that define or record traits differently from what is suggested by World Holstein Friesian Federation.

Key words: conformation traits, dairy international evaluation, genetic correlations, cluster analysis

RUNS OF HOMOZYGOSITY REVEAL GENOME-WIDE AUTOZYGOSITY IN THE AUSTRIAN FLECKVIEH CATTLE

Maja FERENCAKOVIC*¹, Edin HAMZIC², Birgit GREDLER², Ino CURIK¹, Johann SÖLKNER²

¹ *Department of Animal Science, Faculty of Agriculture, University of Zagreb;* ² *University of Natural Resources and Life Sciences Vienna, Department of Sustainable Agricultural Systems, Division of Livestock Sciences*

Corresponding author: Maja FERENCAKOVIC, +38512393660; mferencakovic@agr.hr

Runs of homozygosity (ROH) are recognized as potential inbreeding measure in studies on humans. Inbreeding coefficients derived from ROH (F_{ROH}) measure proportion of the genome arranged in long homozygous segments and highly correlate with those derived from pedigree (F_{ped}). From that we assumed that ROH represent an alternative to pedigree inbreeding levels in studies on animals too, because pedigree can be incorrect, incomplete and can not fully explain what happened in meiosis. To confirm our premise we used pedigree and genotype data from 500 Austrian dual purpose Simmental bulls to determine correlation between F_{ROH} and F_{ped} . ROH were obtained using Fortran 90 software created by the authors. Proportions of genome in ROH were calculated for lengths of ROH of >1, >2, >4, >8 and >16 Mb. Pedigree data were analyzed and inbreeding coefficients for complete pedigree (F_{pedT}) and five generations (F_{ped5}) were calculated using ENDOG software. We found low F_{pedT} and F_{ped5} (means of 1.5% and 0.9%) while F_{ROH} for segments >1Mb suggested much higher values (9.0%) indicating old inbreeding that can not be traced using pedigree. The highest correlations were found between F_{ROH} calculated from ROH of length >4Mb and F_{pedT} (0.68) that is consistent with studies on humans. We conclude that inbreeding coefficients derived from ROH are useful for measuring levels of inbreeding in cattle, because ROH are not subject to mistakes as pedigrees and calculations made from those.

Key words: inbreeding, runs of homozygosity, genome-wide autozygosity, pedigree, cattle

HOW TO USE LESS MARKERS IN ADMIXTURE STUDIES?

Anamarija FRKONJA^{*1}, Birgit GREDLER², Urs SCHNYDER², Ino CURIK³, Johann SÖLKNER¹

¹University of Natural Resources and Life Sciences Vienna, Department of Sustainable Agricultural Systems, Division of Livestock Sciences, ²Qualitas AG, Zug ³University of Zagreb, Faculty of Agriculture, Department of Livestock Sciences

Corresponding authors: **Johann SÖLKNER**, +431476543271; +431476543254; johann.soelkner@boku.ac.at; **Anamarija FRKONJA**, +431476543258; +431476543254; anamarija.frkonja@boku.ac.at

Swiss Fleckvieh has been established from 1970 as a composite of Simmental and Red Holstein Friesian cattle. Breed composition is currently reported based on pedigree information. Information on ancestry informative molecular markers potentially provides more accurate information. For the analysis Illumina Bovine SNP50 Beadchip data for 495 bulls were used. Markers were selected based on difference in allele frequencies in the pure populations, using F_{ST} as an indicator. Performance of sets with decreasing number of markers was compared. The scope of the study was to see how much we can reduce the number of markers based on F_{ST} to get a reliability that is close to that with the full set of markers. On these sets of markers hidden Markov models (HMM) and methods used in genomic selection (BayesB, partial least squares regression, LASSO variable selection) were applied. Correlations of admixture levels were estimated and compared with admixture levels based on pedigree information. F_{ST} chosen SNP gave very high correlations with pedigree based admixture. Only when using 96 and 48 SNP with the highest F_{ST} , correlations dropped to 0.92 and 0.90, respectively.

Key words: admixture, Swiss Fleckvieh, breed composition, AIM

**EFFECTS OF STEAROYL-CoA DESATURASE 1 AND
STEROL REGULATORY ELEMENT BINDING PROTEIN
GENE POLYMORPHISMS ON MILK PRODUCTION,
COMPOSITION AND COAGULATION PROPERTIES OF
INDIVIDUAL MILK OF BROWN SWISS COWS**

Alice MAURMAYR¹, Cinzia RIBECA¹, Alessio CECCHINATO¹,
Mauro PENASA¹, Massimo DE MARCHI¹, and Giovanni
BITTANTE¹

¹*Department of Animal Science, University of Padova*

Corresponding author: Alice Maurmayr +39 049 827 2614; +39 049 827 2633;
alice.maurmayr@studenti.unipd.it

Associations between stearoyl-CoA desaturase (*SCD*) and sterol regulatory element binding protein (*SREBP-1*) gene polymorphisms and milk production, composition (fat, protein, and casein content), acidity (pH and titratable acidity) and coagulation properties (MCP), namely rennet coagulation time (RCT, min) and curd firmness (a_{30} , mm) were investigated on individual Brown Swiss milk. A total of 294 cows from 16 herds and progeny of 15 sires were milk-sampled once. The additive effects of *SCD* and *SREBP-1* genotypes on the aforementioned traits were analyzed through Bayesian linear models. The *SCD* gene was associated with protein content, casein content and a_{30} . Lower protein, casein and a_{30} was observed for milk yielded by *SCD* V than A cows, whereas for other traits the effect was trivial. Animals carrying the L allele of *SREBP-1* showed higher fat content than animals carrying the S allele. These results suggest a possible use of these loci in gene-assisted selection programs for the improvement of milk quality traits and MCP in Brown Swiss cattle, although large scale studies in different breeds are required.

Key words: stearoyl-CoA desaturase (*SCD*), sterol regulatory element binding protein (*SREBP-1*), coagulation property, milk production traits

USE OF SNP MARKERS WITHIN THE *FAT MASS AND OBESITY-ASSOCIATED (FTO)* GENE TO VERIFY PEDIGREES AND DETERMINE HAPLOTYPES IN PATERNAL HALF-SIB FAMILIES OF SLOVENIAN SIMMENTAL CATTLE

Daša JEVŠINEK SKOK^{*1}, Tanja KUNEJ¹, Andrej RENČELJ¹,
Andrej RAZPET¹, Peter DOVČ¹, Silvester ŽGUR¹, Nežika
PETRIČ¹, Martina PLANINC¹, Špela MALOVRH¹, Milena
KOVAC¹, Simon HORVAT^{1,2}

¹ *University of Ljubljana, Biotechnical faculty, Department of Animal Science,* ²
National Institute of Chemistry, Ljubljana

Corresponding author: Daša JEVŠINEK SKOK, +38613203867; +38617241005;
dasa.jevsinek.skok@bf.uni-lj.si

The objective of this preliminary study was to identify SNP markers within the *FTO* gene for evaluation of pedigree data accuracy and determination of haplotypes in paternal half-sib families of Slovenian Simmental cattle. Out of 23 polymorphic SNPs identified ten most informative SNPs for genotyping 31 sires and 56 half-sib progeny were used. The ATLAS program was used for paternity testing. Haplotype analysis revealed three haplotype blocks. The effect of SNPs “ex2 T>C” and “int2 indel*>T” was significant on three correlated carcass traits: live weight at slaughter ($P= 0.03$), carcass weight ($P= 0.038$), and lean weight ($P= 0.048$). The *FTO* gene can thus be regarded as a candidate for the marker assisted selection programs in our and possibly other populations of cattle. Future studies in cattle might also reveal novel roles of the *FTO* gene in carcass traits on livestock species as well as fatness control in other mammals.

Key words: cattle, growth, *FTO*, SNP, haplotype

4. BREEDING AND GENETICS

4.5. POSTERS

THE EFFECT OF MYOGENIC FACTOR 5 POLYMORPHISM ON THE MEAT QUALITY IN CHINESE *Bos taurus*

J. A. UJAN¹, L. S. ZAN^{1,*2}, H. B. Wang^{1,2}, S.A. UJAN³

¹ College of Animal Science and Technology, Northwest A&F University, Yangling ² National Beef Cattle Improvement Centre, Yangling, ³ Government Sachal Sarmast College Ranipur, Shah Abdul Latif University, Khairpur

Corresponding author: **L. S. ZAN**, + 86-29-87091247; +86-29-87092614;
zans@yahoo.com.cn

In the present study, we evaluated polymorphism of myogenic factor 5, involved in growth and meat quality traits. Based on PCR-SSCP technology, a novel missense substitution SNP (single-nucleotide polymorphism) g.1142 A > G was identified in the intron1 region of the MyF -5 gene, it causes an amino acid substitution (¹¹⁴²Glutamine/Glycine¹¹⁴²). Allele frequencies, gene heterozygosity, effective allele number and polymorphism information content of the bovine MyF -5 SNP in three population breeds were determined and evaluated by the χ^2 test. Results showed that the polymorphism distribution was not similar in all of the three *Bos taurus* breeds, the genotype distributions of two cattle breeds Jia xian red and Nanyang did not agree with Hardy–Weinberg equilibrium ($P < 0.01$); one breed Qinchuan did not deviate significantly from Hardy–Weinberg equilibrium ($P > 0.05$). The A/G allelic frequencies in these breeds were 0.797/0.202, 0.770/0.229, 0.863/0.136 respectively. The genotype frequencies in Jia xian red and Nanyang cattle breeds showed moderate diversity ($0.25 < \text{polymorphism information content} < 0.5$). Furthermore, least squares analysis revealed significant effects of genotype on intramuscular fat, rib area and water holding capacity in 510 individuals ($P < 0.05$). Our result suggests that A1142G SNP can be used as an efficacious genetic marker for meat quality traits in native Chinese cattle breeds (*Bos taurus*) but a much large number of animals are required for Marker assisted selection.

Key words: allelic frequencies, Chinese *Bos taurus*, myogenic factor 5, meat quality, single nucleotide polymorphism

PEDIGREE ANALYSIS OF SLOVAK PINZGAU BREED

Ondrej KADLEČÍK*, Radovan KASARDA, Ivan PAVLÍK, Eva HAZUCHOVÁ

Slovak University of Agriculture in Nitra

Corresponding author: Ondrej KADLEČÍK, +421 37 6414 291; ondrej.kadlecik@uniag.sk

The aim of the study was to assess genetic variability in Slovak Pinzgau breed using pedigree analysis. The whole population consisted of 8311 individuals of that 2399 living animals (2373 cows and 26 sires) in the reference population. Pedigree completeness, parameters based on probability of identity by descent and gene origin was analysed. The mean inbreeding level in the reference population was low 0.57%, mean individual increase in inbreeding 0.25% and average relatedness 1.17%. A total 141 effective founders and 51 effective ancestors were found in the reference, resp. 257 effective founders and 103 effective ancestors in the whole population. The number of 21 effective ancestor explained 50% of diversity in the reference and 51 in the whole population. The results demonstrate need for better monitoring of population and can be implemented in preparation of the strategy for development of breed.

Key words: Pinzgau cattle, pedigree analysis, genetic diversity, inbreeding, relatedness, probability of gene origin

**PHENOTYPIC RELATIONSHIPS BETWEEN LONGEVITY
AND UDDER CONFORMATION TRAITS IN THREE
HUNGARIAN HOLSTEIN-FRIESIAN HERDS**

Szilvia SZÖGI, Árpád BOKOR, István HOLLÓ

Kaposvár University Faculty of Animal Science

Corresponding author: Szilvia SZÖGI +36304689215 szogi.szilvia@ke.hu

The phenotypic relationships between udder conformation type traits (fore udder attachment, rear udder height, rear udder width, teat length, fore teat position, rear teat position, central ligament, udder depth and udder as a main type trait) and longevity of 5621 Holstein cows from three different Hungarian herds were analyzed. This study aimed to examine which udder type trait had an effect on the longevity. Longevity trait was defined as the number of milking days from first calving to culling, which is the effective number of milking days. Phenotypic correlation was analyzed using Pearson correlation and a general linear model was used in order to analyze the effect of investigated udder traits for the longevity. All analyzed traits showed a moderately negative correlation ($r=-0.5-0.11$) with longevity except for rear udder width ($r=0.37$). The udder depth, the rear udder width and the rear teat placement had significant effect on the longevity. In case of udder depth and rear teat placement the cows with undesirable points had longer productive life. In our study the examination was restricted to three Hungarian herds so the received results are only preliminary. Additional analyses and using further statistical methods would be necessary to explain this opposite connection between the longevity and the most udder traits.

Key words: longevity, Holstein-Friesian, udder traits

**THE T945M SINGLE NUCLEOTIDE POLYMORPHISM OF
THE BOVINE LEPTIN RECEPTOR GENE IN POPULATION
OF SLOVAK SPOTTED BULLS**

Anna TRAKOVICKÁ, Nina MORAVČÍKOVÁ*, Martina
MILUCHOVÁ

*Slovak University of Agriculture in Nitra, Department of Animal Genetics and
Breeding Biology*

Corresponding author: Nina MORAVČÍKOVÁ +421 37 6414 295;
nina.moravcikova1@gmail.com

The objective of this study was detection of DNA polymorphism of the leptin receptor gene using the polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP). The SNP T945M, which maps on bovine chromosome 3 at the exon 20 of the leptin receptor sequence and corresponds to a mutation in the intracellular region of the functional protein, was also analyzed. In exon 20, a T to C missense mutation was found at nucleotide 115, which causes an amino acid substitution at residue 945 (T954M). The polymorphism of leptin receptor gene was studied in a group of 57 bulls of Slovak spotted breed. A strategy employing PCR was used to amplify 197 bp products from blood samples. Digestion of PCR products with restriction enzyme *BseGI* revealed two alleles: allele C was 130 and 67 fragments and allele T was 93, 67 and 37. Frequencies for allele C and T were 0.9737 and 0.0263, respectively and TT genotype was not detected.

Key words: bovine leptin receptor gene, cattle, polymorphism, SNP T945M

RELATIONSHIP BETWEEN PRODUCTION AND REPRODUCTION TRAITS DAIRY COWS OF SLOVAK SPOTTED BREED

Jozef BUJKO¹, Juraj CANDRÁK¹, Július ŽITNÝ¹, Cyril HRNČÁR²

¹ Department of Genetic and Breeding Biology, Slovak Agricultural University in Nitra,

² Department of Poultry Science and Small Animal Husbandry, Slovak Agricultural University in Nitra

Corresponding author: **Jozef BUJKO**, +421376414294, Jozef.Bujko@uniag.sk

The aim this work was to evaluate relationships between production and reproduction traits in herds of Slovak spotted breed in the period 1990-2010 the results for 6 938 cows: milk, fat and proteins in kg and reproduction traits: age at first, second, third calving and calving interval. The basic statistic analysis were analysed using the SAS version 9.1. In the first lactation of dairy cows produced 4 003.5 kg of milk, 170.9 kg of fat and 133.3 kg of proteins. An increase of traits milk production in the second lactation was 11.3 - 12.1 % for milk traits. In the third lactation a slight increase in traits of milk production was achieved in comparison with the previous one, with a range of 4.6 % - 5.6 %. Mean age at first, second and third calving in data set were 945.0, 1 348.3 and 1 748.6 days. Average length between first and second calving was 415.5 days and between second and third calving was 408.3 days. Results of relation between kgs of milk by groups were higher value length calving interval in M₃ (431.9 days). Correlation between evaluated traits of milk production and age at first calving were lower negative and statistically high significant ($P < 0.0001$), scilicet between kgs of milk age at first calving $r = -0.0764$ and between milk in kg with calving interval 1 ($r = 0.1312$) and with calving interval 2 ($r = 0.0898$) were statistically high significant ($P < 0.0001$). The analyses by the effect on age of first calving was the highest effect of herd-years-season $R^2 = 0.4699$ and on calving interval was the highest effect of herd-years-season $R^2 = 0.1511$. This work was supported by projects of VEGA No. 1/0769/09 and 1/0061/10.

Key words: Slovak spotted breed, age of first calving, calving interval, milk production, correlation

ESTIMATION OF GENETIC PARAMETERS FOR MILK UREA AND MILK PRODUCTION TRAITS OF LATVIAN BROWN COWS

Daina JONKUS*¹, Liga PAURA¹

¹ *Latvia University of Agriculture, Liela*

Corresponding author: Daina JONKUS +3713005707; daina.jonkus@llu.lv

The objectives of this study were to determine the effects of environmental and physiological factors on milk urea content (MU) and milk production traits and to estimate heritability and repeatability for MU and milk production traits. Milk yield and MU, fat, protein, lactose, somatic cell count (SCS) and freezing point (FP) of milk were collected from the herd control data from August 2008 to August 2009 from dairy herd of the Study and research farm "Vecauce" of the Latvia University of Agriculture. Milk content parameters for total 794 milk samples were analyzed in accredited milk quality laboratory. The investigation data was processed using a program SPSS. Genetic parameters of MU and milk production traits were estimated by REML method using WOMBAT software applying a repeatability animal model. The average MU was 16.55 mg dL⁻¹ and milk yield was 20.37 kg per test day. The average fat, protein and lactose contents were 4.60, 3.56 and 4.70%, respectively. The average SCS and FP of milk were 2.40 and minus 0.529°C. Milk productivity traits varied depending on season, lactation number and stage of lactation (p<0.001) expected fat content, which is not affected by lactation number. MU and FP varied depending on season and milking systems (p<0.001). Estimated heritability for MU (0.072) and FP (0.062) were low and moderate for milk production traits.

Key words: dairy cattle, genetic parameter, milk yield, urea

**GENOTYPE OF MELATONIN RECEPTOR MT1 (MTNR1A)
AND PUBERTY IN MEDITERRANEAN ITALIAN BUFFALO**

Marta PALUDO, MURA M. C., LURIDIANA S., Michele
PAZZOLA, DAGA C., Giuseppe Massimo VACCA, BUA S.,
BODANO S., SANNA G. A., Vincenzo CARCANGIU

Dipartimento di Biologia Animale, Università degli Studi di Sassari

Corresponding author: Vincenzo CARCANGIU +39079229436; endvet@uniss.it

In adult buffaloes, polymorphism of the MT1 receptor gene has shown to influence the reproductive seasonality. The aim of study was to assess whether the polymorphism of the MTNR1A gene may influence puberty in Mediterranean Italian buffalo. The study was conducted using 50 prepubertal buffalo cows that at the age of 15 months were placed into the group where there was the male. Estrus detection was performed by observing estrous-behaviour and pregnancy checking by palpation per rectum and/or ultrasound between days 40 and 60 post-mating. Also of each animal dates of calving was recorded. From each buffalos a blood sample was collected and used for DNA extraction. PCR analysis was performed using 100-150 ng of DNA to amplify the second exon of the MTNRA1 gene. All PCR products were digested with 2U of enzyme HpaI to highlight the polymorphism at position 82 (characterized by a C to a T substitution) of the MTNR1A gene. Frequency of C and T alleles was respectively 0.42 and 0.58 in the analyzed population which resulted in Hardy Weinberg equilibrium. The genotypic frequency was 28% for genotype C/C, 38% for C/T and 34% for T/T. The registration of reproductive data showed that the first heat is around the age of 20 months and the first calving around 32 months. Our data show that the genotype of the MTNR1A does not influence the onset of reproductive activity in prepubertal buffalo cows.

Key words: buffaloes, melatonin receptor, seasonal reproduction, puberty

**POLYMORPHISM OF CAPRINE SLC11A1 GENE AND
RELATIONSHIPS WITH HYGIENIC CHARACTERISTICS
OF MILK**

Gianpiera PIRAS, Michele PAZZOLA, Filippo BALIA, Emanuela
PIRA, Maria Luisa DETTORI, Vincenzo CARCANGIU, Giuseppe
Massimo VACCA

Department of Animal Biology, University of Sassari

*Corresponding author: Michele PAZZOLA +39079229509; +39079229592;
pazzola@uniss.it*

The solute carrier family 11 member A1 (*SLC11A1*) gene is associated with resistance to infectious diseases. Genetic variability of at the 3' untranslated region (3'-UTR) of this gene is due to the presence of a polymorphic microsatellites that contain a (GT)_n dinucleotide repeat. The microsatellite variability and relationships with milk yield and composition, somatic cell count (SCC) and total microbic count (TMC) were investigated in 260 goats of Sarda breed. Genotyping of the upstream guanine-thymine repeat (GT)_n revealed twenty different genotypes and eight alleles (GT11, GT12, GT14, GT15, GT16, GT17, GT18 and GT19). The present study confirmed the high genetic variability of the Sarda goat and that the genotype of the microsatellite at 3'-UTR *SLC11A1* affected many chemical and hygienic characteristics of milk as fat, protein and SCC.

Key words: goat, milk, *SLC11A1*, hygiene

GEOGRAPHIC INFORMATION SYSTEMS (GIS) FOR LIVESTOCK SCIENCE: APPLICATIONS AND CASE STUDIES

Enrico STURARO^{*}, Giampaolo COCCA, Elisa MARCHIORI,
Maurizio RAMANZIN

Department of Animal Science, University of Padova

Corresponding author: Enrico STURARO +39(0)49 8272641; +39(0)49 8272669; enrico.sturaro@unipd.it

In the last years the use of Geographic Information Systems (GIS) software has been increasing in many scientific areas. Environmental science, ecology, biodiversity conservation and geography are specific disciplines where GIS find fundamental applications. Also in agriculture and veterinary science approaches using GIS are increasing, especially for environmental sustainability and disease monitoring. Surprisingly only few papers using GIS in livestock science have been so far published in journals of Agriculture, Animal and Dairy Science, according to the ISI web of Science classification. This work offers an overview on GIS applications in livestock science, taking into account pros and cons of different software and providing some examples taken from the recent literature. Although literature offers examples in which GIS has been fruitfully applied in many different branches of livestock science, the relevance of this technology in livestock science specific journals is still modest. Its success will probably depend upon a clear understanding of the potential applications that arise from shifting the scale of analysis from the animal/farm to the landscape level.

In conclusion, GIS techniques offer a large set of applications in livestock science, and the use of these tools must be encouraged.

Key words: environment, geographic information system, livestock, software, spatial data

PRODUCTION AND BEHAVIORAL TRAITS OF HONEYBEE QUEENS FROM CROATIAN BREEDING PROGRAM

Marica Maja DRAŽIĆ*¹, Janja FILIPI² Joso BRAJKOVIĆ³, Mladen KRUŠELJ⁴, Nikola KEZIĆ⁵

¹ Croatian Agricultural Agency; ² Polytechnic "Marko Marulić", Knin, ³ Croatian chamber of economy, Otočac, ⁴ Grad Zlatar; ⁵ Faculty of Agriculture University of Zagreb

Corresponding author: Marica Maja DRAŽIĆ +38513903125; mdrazic@hpa.hr

The value of beekeeping is comparable to other agricultural productions, placing beekeeping among the most economically important livestock productions due to its role in pollination. In Croatia, beekeeping is based on Carniolan bee (*Apis mellifera carnica*), autochthonous on the whole territory of Croatia, which is dominantly used for honey production, followed by pollen and propolis production, queen rearing and package bees. The number of queen bees annually reared in Croatia ranges from 25.000 to 30.000 from 30 registered queen breeding apiaries, and averagely 350 queens in performance test per year. The aim of this paper was to give an overview of the main traits of Carniolan queens reared and tested in Croatia in period from 2006 to 2010. The differences between colonies from Mediterranean and continental region in colony dynamics and strength are evident, as well as honey production. The honey production showed high variability within and between test years in both regions. The behavioural traits are more consistent between these two populations. The data enable comparisons of queens within season, however with further data improvement, the breeding value estimation can be introduced using currently available methods, such as BLUP Animal Model.

Key words: *Apis mellifera carnica*, queens, breeding program, traits, performance test

ANALYSIS OF CONFORMATION TRAITS IN SLOVENIAN POSAVJE HORSE

Klemen POTOČNIK¹, Matjaž MESARIČ²

*1 University of Ljubljana, Biotechnical Faculty, Zootechnical Department, 2
University of Ljubljana, Veterinary Faculty*

*Corresponding author: Klemen POTOČNIK +386 13 20 38 72;
klemen.potocnik@bf.uni-lj.si*

Posavje horse is a smaller draft horse mostly breed in Posavje region which spans in Slovenia and Croatia. Slovenian breeders are organised as a breeding organization and give great importance to the selection. In year 2005 new breeding program (Rus, 2005) which provides quite strong selection on conformation traits was adopted. Conformation traits of Posavje horse were analyzed to recognize the efficiency of selection. Classification of conformation traits started in year 2000 in first year less than 20 horses were classified and in the last five years more than 60 horses were classified annually. Classification system includes 9 measured and 11 judged (on 10 points scale) traits. In our study data of 557 horses (44 stallions and 513 mares) from eleven classified years were analysed. The results show that conformation traits characteristics are similar as for known characteristic of Croatia population of Posavje horse. Phenotypic trends for measured trait show that Slovenian population of Posavje horse brings it closer towards breeding goals. Variance analysis shows that the most important environmental effect is the birth year, for some traits also sex had statistical significant effect, but age at classifying had statistically significant effect only on body length.

Key words: Posavje horse, conformation traits, body measurements, classification

CROSSBREEDING EFFECTS OF LORI BLACK GOAT × SAANEN ON THE SOME GROWTH & MILK TRAITS IN QOM PROVINCE

M. Hosseini Ghomi¹, A. Ghazi Khani Shad², M. Kalantar³

¹ M.Sc Student, Islamic azad University, Saveh Branch, ² Department of Animal Science, Saveh Branch, Islamic Azad University, ³ Agricultural Research Center of Qom

Corresponding author: **Seyed Mehdi HOSEINI GHOMI**,
gentelmanmehdi@yahoo.com

In this study the performance of some growth and milk traits of selected Qomi native (Lori black) goats and Saanen × native goats during 2008-2010 was compared. Growth traits was included birth weight (BW), one-month weight (1MW), weaning weight (WW) and 6-month weight (6MW). The milk production traits as quantitative traits were compared in 2, 3, 4, 5th months of production period. Also the milk composition traits included dry matter (%DM), fat (%F), and protein (%P) percentage on during of production as qualitative traits was compared. There were no significant differences in sex, birth type and genetic group for BW. Also the effect of genetic groups on 1MW, WW, and 6MW was significant, while effects of sex and birth type on 1MW, WW and 6MW was not significant. Also MW (Mothers' weight) had no significant effect on BW, 1MW, WW and 6MW. The average of daily milk records was 0.48kg for native and 1.1kg for crossed goats. The maximum monthly milk records in two groups was in second month (native: 0.64±0.05, crossed: 1.44±0.12) and the minimum was in fifth month (native: 0.36±0.03, crossed: 0.77±0.05). %DM, %F and %P in 5th month was higher than other months in two groups. Effects of genetic groups on milk production and also on average of %F, %DM and %P was significant. This study showed that the crossbreeding has a significant effect on most milk production and growth traits in Iranian native goats.

Key words: Saanen goat, Qomi native goat, growth traits, milk traits

5. PLENARY LECTURES

Quadrilateral collaboration in animal science as a perspective for improvement of education and production

QUADRILATERAL COLLABORATIONS IN THE FIELD OF ANIMAL SCIENCE – OUTCOME AND FUTURE PROSPECTS

Gábor MILISITS, Csaba SZABÓ, Melinda KOVÁCS, József STEFLER

Kaposvár University, Faculty of Animal Science,

Corresponding author: Gábor MILISITS, +3682505800; +3682320175; milisits.gabor@ke.hu

Summary

In this paper authors reviewed the history of the International Symposium „Animal Science Days” from the beginning up to now. After showing the antecedents of this scientific meeting, the places and topics of the former symposiums were demonstrated. After reviewing the development of this event in the last 18 years, collaborations based on the quadrilateral cooperation of the partner universities were demonstrated. As results of this scientific cooperation, common publications and also the importance of collaboration in the field of education were evaluated. For further collaborations the fields of common interests and also the internationally available funding were demonstrated. Based on this review it was concluded that “Animal Science Days” symposium contributed significantly to the scientific and educational life of each partner university and the agriculture of the Alps-Adriatic region. The partner universities have further possibilities to extend their collaborations, but a joint lobby for creating new funding possibilities would be a great help for them.

Key words: Quadrilateral partner universities, animal science, international funding, collaboration

1. Antecedents, beginning of the collaboration

It is an old experience that successful cooperations are based on good private relations. It is the same in the case of the “Animal Science Days” international symposium too. The initiator of this regularly organized scientific meeting was professor János Ember, whose professional career spanned over the borders between Hungary and

the present states of the former Yugoslavia. Based on his personal connections he inspired the leaders of the university and its legal predecessor in Kaposvár to establish the obvious cooperation taking the advantage of the geographical nearness into consideration. His colleagues from the universities in Osijek (Gordana Kralik and Antun Petričević), Zagreb (Marija Đikić) and Ljubljana (Slavko Čepin and Franc Habe) furthered his intentions.

At the beginning of this cooperation, colleagues from the partner universities visited each other and exchanged their experiences in the field of animal husbandry. At that time Yugoslavia was intending to establish big size animal farms and it was obvious to implement the experience of Hungary.

The other mutual point was the horse sport. The horse-riders of the Adriatic region have become permanent participants of the international dressage tests, which were regularly organized in Kaposvár.

The direct scientific research cooperation was started later in order to find solutions commonly for the different problems in animal husbandry. The most active research fields were the poultry, pig and cattle production.

2. Start of the „Animal Science Days” symposium

From this point on only one step was needed to organize the first common scientific conference (International Symposium „Animal Science Days”), which was organized in 1993 by the PANNON Agricultural University, Faculty of Animal Science, in Kaposvár, in Hungary. According to the agreement of the founder universities the following symposiums were organized in a circular system. The participating countries hosted the symposium every year in the following order: Hungary, Croatia, Slovenia. After Italy (representing by University of Padova, Faculty of Agriculture) joined to the collaboration, the symposium was organized in every fourth year in the same country.

The main topic of the symposium was chosen by the host country every year. As it is visible in *Table 1.*, very wide area of animal husbandry and animal production was discussed during the last 18 years.

The scientific program of the symposium always started with the plenary lectures of each country representatives in the frame of the

main topic of the symposium. The further oral presentations were divided into different sections according to animal species or topic of the presentations. Next to the oral presentations also posters were always presented during the symposium.

The official language of the symposium was the language of the host country and German and English in the first 9 years. During this time simultaneous translation into English was always provided. In order to simplify the organization and to improve the level of the symposium the official language of the symposium was changed to English in 2002.

Table 1. Places and topics of „Animal Science Days” (ASD) symposiums

Serial number of ASD Symposium	Year	Place	Topic
1st	1993	Kaposvár (Hungary)	Qualification of animal products and possibilities of their quality improvement
2nd	1994	Rovinj (Croatia)	Research and practice in agriculture and food technology
3rd	1995	Bled (Slovenia)	Perspectives in the production of various kinds of meat
4th	1996	Kaposvár (Hungary)	Animal production, healthy nutrition, environment
5th	1997	Opatija (Croatia)	
6th	1998	Portorož (Slovenia)	Quality adjustment of animal production and products to the European Union standards
7th	1999	Balatonföldvár (Hungary)	The present situation and tasks to be accomplished in animal production prior to entry into the European Union
8th	2000	Osijek (Croatia)	Animal products and human health

Plenary lectures

9th	2001	Radenci (Slovenia)	Meat and milk production of the future
10th	2002	Pécs (Hungary)	Environment friendly and EU conform animal husbandry
11th	2003	Poreč (Croatia)	Competitiveness of livestock production during the process of the EU integration
12th	2004	Bled (Slovenia)	Animal production according to ecological, ethological and ethical norms
13th	2005	Padova (Italy)	Husbandry, food and environment. The new challenges of the animal science
14th	2006	Lillafüred (Hungary)	Future trends of research on food quality and safety
15th	2007	Osijek (Croatia)	Recent advances and future priorities of animal product quality in EU
16th	2008	Strunjan (Slovenia)	Sustainable Farm Animal Breeding
17th	2009	Abano Terme (Italy)	Priorities for the European animal production in a global market
18th	2010	Kaposvár (Hungary)	Possibilities and delimitations of extensive animal husbandry

Thanks to this change the discussions after the presentations were ever intensiver and therefore the professional importance of this symposium became also higher. From this time forth the symposium provided a very good opportunity for the PhD students to make oral presentations in English language and to take part more actively in the discussions.

3. Current situation

Because of the relative low number of participants (about 80 in every year) very good partnerships and friendships were evolved between the participants from different countries and universities. Based on these friendships and common interests many cooperations were started between the participating universities in the last years. In the field of research many experiments were carried out in the rabbit and poultry breeding in the cooperation of the Kaposvár and Padova universities. These experiments were mainly focused on the *in vivo* determination of body composition (*Milisits et al.*, 1999) and later on animal welfare in rabbit breeding (*Princz et al.*, 2008; *Dalle Zotte et al.*, 2010; *Szendrő and Dalle Zotte*, 2011) and on the practical applicability of the *in vivo* determination of egg composition in poultry breeding (*Dalle Zotte et al.*, 2011). These common projects have used the very good experimental infrastructure and *in vivo* egg and body composition analysis (by means of computer tomography) in Kaposvár and the high quality laboratory background for meat sample analysis in Padova.

The laboratory background of the Kaposvár University is often used in the cooperation with the Josip Juraj Strossmayer University in Osijek (Croatia). From the chemical analysis of different samples the determination of fat and fatty acid content of different meat samples was realized in common publications (*Kralik et al.*, 2004, 2006).

In the field of the statistical data analysis cooperations are based on the knowledge of the colleagues at the University of Zagreb (Croatia). A lot of production data originated from Hungarian databases were analyzed with their help (*Nagy et al.*, 2009, 2010). Some pedigree analyses and inbreeding examinations were also done in the frame of these cooperations (*Farkas et al.*, 2007).

In the field of the genetic studies cooperations between Croatia and Slovenia were also observed (*Potočnik et al.*, 2006, 2009).

The cooperation between Italy and Slovenia can be observed in the field of cattle breeding. The common research is focused on the study of feeding and social behaviour of fattening Cika young bulls.

In a trilateral cooperation between Croatia, Italy and Slovenia milk production is also represented as common research interest of the partner universities (*Gantner et al.*, 2009a). Similar research works were done also in Croatian-Slovenian collaboration (*Gantner et al.*, 2009b, 2010).

The possibility in the ERASMUS program and also in some other bilateral agreements is frequently used for exchange teachers and researchers among the participating universities. Colleagues are often invited to be a speaker at conferences or to give lectures for colleagues and/or students in specific topics at some of the partner universities.

4. Common publications

Due to the intensive cooperations between the participating universities a lot of common publications were appeared in different high quality scientific journals (*Acta Alimentaria, Annales de Zootechnie, Applied Animal Behaviour Science, Journal of Animal Science, Livestock Science, Meat Science, World Rabbit Science, etc.*), and in international conference proceedings (*World Rabbit Congress, International Congress of Meat Science and Technology, European Symposium on the Quality of Eggs and Egg Products, European Symposium on the Quality of Poultry Meat, etc.*). In Table 2. the number of common publications at the Animal Science Days Symposiums is summarized covering the 18 years history of this cooperation.

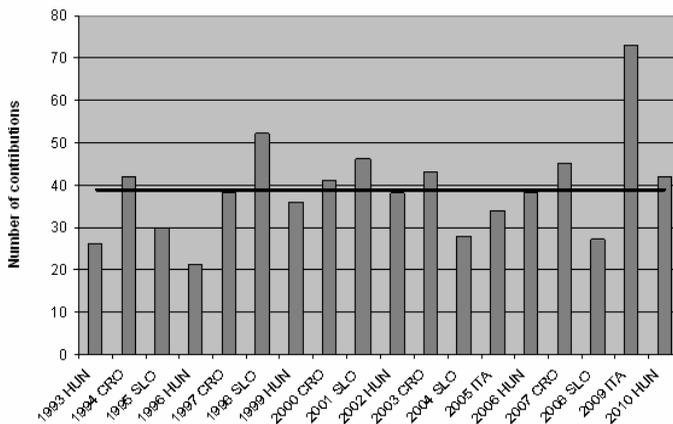
From this table it is well visible that – due to the common historical background and very similar languages – the cooperation between Croatia and Slovenia was the most active. Some common papers were published also from the cooperations between Croatia and Hungary and Hungary and Italy, but the cooperation between Croatia and Italy, Hungary and Slovenia and Italy and Slovenia could be more active in the future.

The average number of contributions – without presentations of the plenary sessions – was 38.9 at the ASD conferences in the last 18 years (*Figure 1.*). The number of contributions was mainly between 30 and 50 irrespectively of the organizing country. In spite of the natural fluctuations around the mean value, even tendency can not be observed regarding to country preference ($P>0.05$). The lowest number of contributions (21) was presented in 1996, while the highest (73) in 2009.

Table 2. The number of common publications at the Animal Science Days symposiums between 1993 and 2010 in different cooperations of the participating countries

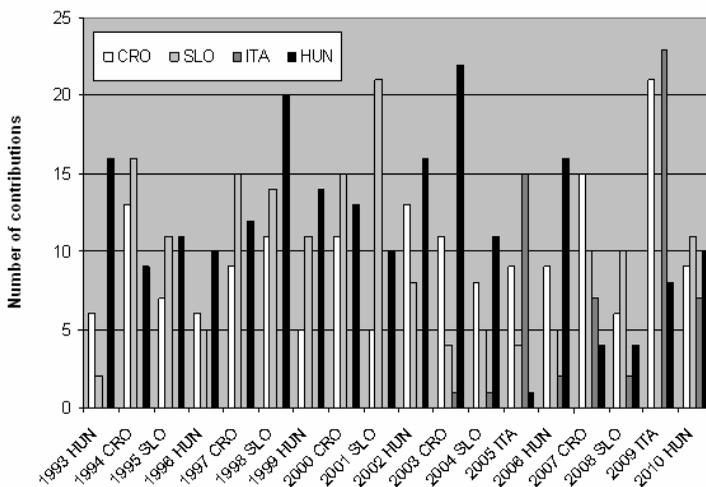
Co-operation	Number of publications
Croatia – Hungary	4
Croatia – Italy	1
Croatia – Slovenia	17
Hungary – Italy	5
Hungary – Slovenia	-
Italy – Slovenia	-

Figure 1. Total number of contributions at the ASD conferences



The number of contributions grouped by the country origin of the presenting authors can be seen on *Figure 2*.

Figure 2. Number of contributions at the ASD conferences grouped by the country origin of the presenting authors



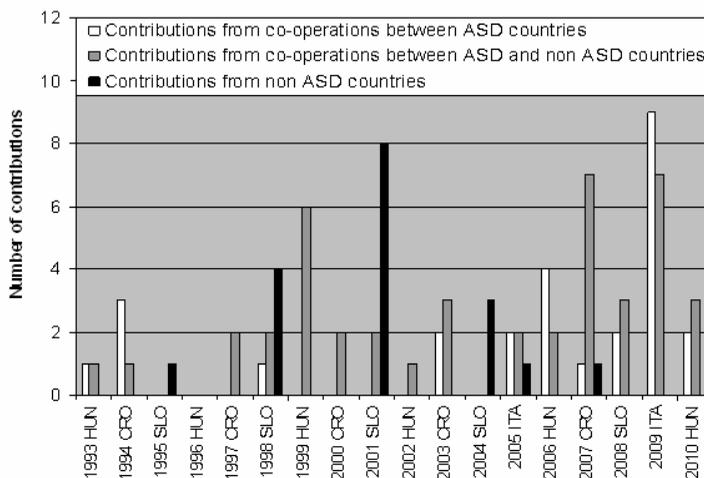
The average contributions were 9.7, 9.6, 7.3 and 11.5 for Croatia, Slovenia, Italy and Hungary, respectively. In the case of Hungary some decline was observed in the number of contributions in the last some years, which is caused by the less activity of researchers of the Faculty of Economics at the Kaposvár University.

On *Figure 3*, the numbers of contributions grouped by the origin of type of cooperations are demonstrated.

On this figure it is well visible that contributors from the ASD countries regularly present their work jointly with researchers outside from the ASD countries. At the early stages of this symposium, researchers of the member countries only occasionally presented joint works, while this type of presentation became more regular in the last some years. However, it reaches only about 5-10% of the total number of the yearly contributions.

Foreign contributors just irregularly visit the ASD conferences. Slovenia seems to be the most active in the invitation of foreign presenters to this scientific meeting.

Figure 3. Number of contributions at the ASD conferences grouped by the origin of type of cooperations



5. Importance of collaboration in the MSC and PHD courses

Thanks to these cooperations year by year more and more students can write their thesis work by using the results of these common experiments. It is also more frequent that students do their experiments (or a part of them) at another partner university and sometimes they write their work in English language.

Using the possibilities in the ERASMUS program students often go to a partner university either for semester long studies or just for short term courses in specific topics. For the more efficient utilization of this very good opportunity the increase of the number of courses in English language seems to be necessary almost at all of the participating universities.

In the different Doctoral Schools some students already write their dissertations from the results of the common research projects of the partner universities. In the future the possibility of common education and the creation of joint diplomas could be considered too.

6. Future prospects

All universities in this quadrilateral collaboration hold a leading position in their country in agricultural science by the facilities, number and qualification of scientists, scientific projects and publications. Research activities cover several areas of interest for sustainable animal production, highlighting on genetic improvement and conservation of biodiversity, nutrition and feeding, welfare and management of livestock, safety and quality of animal products, aquaculture, wildlife biology and management. The research facilities, including infrastructure and human resources, are unique in certain areas and a complementary utilization could be offered.

For further joint research activities internationally available fundings are needed. In Hungary the Hungarian Scientific Research Fund (OTKA) supports mainly basic research, announces programmes for funding projects based on international cooperation. The joint application in English of the two or more research training groups should be submitted to the research funding organisation in their respective countries. The proposal will be supported by OTKA only if all participating funding organisation will support their own applicants.

Since Hungary joined the European Union cooperation possibilities have become wider, mostly operating under the principle that the coordinating body provides only the additional expenses necessitated by the cooperation. The European Science Foundation (ESF) managed EUROCORES projects, also acknowledged and subscribed by OTKA and the Hungarian Academy of Sciences (MTA) are examples for such cooperation.

The Division of Bilateral Affairs of the Hungarian Science and Technology Foundation maintain and develop bilateral international relations of the Hungarian R&D community. The Foundation has been executing the administrative and financial management of the projects approved under the bilateral intergovernmental S&T agreements, which Hungary has signed with more than 30 countries all over the world. Presently the Division handles and administers about 600 mobility and workshop projects annually.

INTERREG IVC provides funding for [interregional cooperation](#) across Europe. The areas of support are innovation and the knowledge economy, and [environment and risk prevention](#). Typical

tools for exchange of experience are networking activities such as thematic workshops, seminars, conferences, surveys, and study visits. Taking the knowledge-maps of the individual institutions as a basis, a database could be created indicating both free capacities and demands for cooperation. Depending on the current proposal for cooperation, the appropriate funding can be selected.

7. Conclusions

Based on the reviewed collaborations it was concluded that “Animal Science Days” symposium contributed significantly to the scientific and educational life of each partner university and the agriculture of the Alps-Adriatic region. The partner universities have further possibilities to extend their collaborations, but a joint lobby for creating new funding possibilities would be a great help for them.

8. References

Dalle Zotte A., Cullere M., Sütő Z., Donkó T., Milisits G. (2011). Effect of Egg Composition and Genotype on the Hatched Broiler's Meat Traits and Meat Composition. XIVth European Symposium on the Quality of Eggs and Egg Products and XXth European Symposium on the Quality of Poultry Meat, Leipzig (Germany), 4-8 September 2011. **Dalle Zotte A.**, Jekkel G., Milisits G. (2010). Examination of the meat quality of growing rabbits reared on wire net or combined (wire net / straw) floor at different stocking densities. 56th International Congress of Meat Science and Technology, Jeju Island (Republic of Korea), 15-20 August 2010, 129. **Farkas J.**, Curik I., Csató L., Csörnyei Z., Baumung R., Nagy I. (2007). Bayesian inference of inbreeding effects on litter size and gestation length in Hungarian Landrace and Hungarian Large White pigs. *Livestock Science* 112:1-2 109-114. **Gantner V.**, Jovanovac S., Klopčic M., Cassandro M., Raguz N., Kuterovac K. (2009a). Methods for estimation of daily and lactation milk yields from alternative milk recording scheme in Holstein and Simmental cattle breeds. *Italian Journal of Animal Science* 8:4 519-530. **Gantner V.**, Jovanovac S., Raguz N., Solic D., Kompan D. (2009b). Effect of milk recording scheme on lactation milk yields prediction accuracy. *Mljekarstvo* 59:1 42-48. **Gantner V.**, Potočnik K., Kuterovac K.,

Gantner R., Antunović B. (2010). Methods for early prediction of lactation flow in Holstein heifers. *Mljekarstvo* 60:4 260-265. **Kralik G.**, Csapó J., Crnjac T. (2006). Feeding rapeseed oil to increase the n-3 PUFA of pork: Fatty acid composition of muscle and adipose tissue. *Acta Alimentaria* 35:3 251-258. **Kralik G.**, Ivankovics S., Bogut I., Csapó J. (2004). Effect of dietary supplementation with PUFA n-3 on the lipids composition of chicken meat. *Acta Alimentaria* 33:2 129-139. **Milisits G.**, Romvári R., Dalle Zotte A., Szendrő Zs. (1999). Non-invasive study of changes in body composition in rabbits during pregnancy using X-ray computerized tomography. *Annales de Zootechnie* 48: 25-34. **Nagy I.**, Curik I., Farkas J., Csató L., Csörnyei Z. (2009). Bayesian inference of genetic parameters on litter size and gestation length in Hungarian Landrace and Hungarian Large White pigs. *Italian Journal of Animal Science* 8:3 68-70. **Nagy I.**, Curik I., Radnai I., Cervantes I., Gyovai P., Baumung R., Farkas J., Szendrő Zs. (2010). Genetic diversity and population structure of the synthetic Pannon White rabbit revealed by pedigree analyses. *Journal of Animal Science* 88:4 1267-1275. **Potočnik K.**, Gantner V., Štepec M., Jovanovac S., Krsnik J. (2006). Genetic evaluation of milking speed for Slovenian Holstein cattle regarding to different scoring approaches. *Acta Agraria Kaposváriensis* 10:2 99-104. **Potočnik K.**, Gantner V., Stepec M., Krsnik J., Rus J., Gorjanc G. (2009). Analysis of inbreeding in Slovenian Haflinger population. *Italian Journal of Animal Science* 8:3 128-130. **Princz Z.**, Dalle Zotte A., Radnai I., Biró-Németh E., Matics Zs., Gerencsér Zs., Nagy I., Szendrő Zs. (2008). Behaviour of growing rabbits under various housing conditions. *Applied Animal Behaviour Science* 111:3-4 342-356. **Szendrő Zs.**, Dalle Zotte A. (2011). Effect of housing conditions on production and behaviour of growing meat rabbits: A review. *Livestock Science* 137:1-3 296-303.

COLLABORATIONS IN THE FIELD OF EDUCATION AT UNIVERSITY LEVEL

Martino CASSANDRO

Department of Animal Science, University of Padova

*Corresponding author: Martino CASSANDRO, +390498272666;
martinocassandro@unipd.it*

Aim

The goals of the present review are the following three:

- a) To present the Bologna process and the recent changing at European high educational level.
- b) To provide an updating on actual situation and perspectives of the PhD system in developed countries and around the world.
- c) To discuss possible models of collaboration across ASD's countries and international systems and institutions of higher education.

Key words: Education, Collaboration, Perspectives, University.

1. Introduction

Changes on systems of public higher education are in progress around the world; a shift is occurring in the support and perception of the purpose of public research universities. Several national governments are attempting to bend their higher education systems to meet their perceived long-term socio-economic needs. At the same time, there are relatively new supranational influences on higher education markets and practices that will grow in influence over time, including the Bologna agreement, the European Commission, and the pending General Agreement on Trade and Services. Generally, changes in several countries have followed careful observation of what has made the U.S. successful, but the change of new emerging countries has not been examined closely, therefore arises the need to find alternative and peculiar solutions for each country.

The U.S. led the world in the development of a cadre of highly productive public research universities and state systems of higher

education. Public universities remain a large social and economic force in the nation, but there are many signs that the international leadership of the U.S. in higher education is fading.

Many nations have sought to adopt elements of the U.S. model on their own political and social terms. Their systems are maturing and they are making great progress (although still too slowly for many critics). New and productive centres of research are emerging in both developed and developing economies; international collaborations among universities are growing and many OECD countries now exceed the U.S. in higher education participation and degree attainment rates for young adults.

While recognizing that there are many reform efforts that relate to the peculiar political cultures and needs of individual nations, it seems to be unanimously agreed that there is commonality in the challenges facing public universities internationally, including:

- The need to expand or maintain access and improve graduation rates.
- Increasing expectations by governments and the public to serve the broad social needs of society.
- Disinvestment by state governments and the need for new financial models.
- Avenues for increasing efficiencies in teaching and university management.
- Increased reliance on research universities as drivers of economic development.
- Growing emphasis on professionalism and scientific and technological prowess.
- Relatively new global markets for academics and research excellence.
- The rise of relatively new and for-profit competitors all over the world.
- Increased global collaborations with other universities and businesses in research and teaching programs.

2. Education at university level in Europe

In **Europe**, the Bologna Agreement, also called Bologna Process or Declaration of Bologna, was underwritten on 19th June 1999, among the ministries of higher education of 29 European countries at Bologna (Italy). This is an important agreement for harmonizing

various European higher education systems that is creating an European area of Higher Education and to promote the European system of higher education on a worldwide scale, in order to increase its international competitiveness. The Declaration of Bologna was preceded by a significant debate on the role of the university in the development of the cultural dimensions of Europe. Two fundamental stages were the "Convention on the recognition of qualifications regarding higher education in the European region", signed in Lisbon in April 1997 by the ministries of education of numerous countries (not only EU), and "The joint declaration of the Sorbonne on the harmonization of the architecture of the European system of higher education," underwritten on the 25th May 1998 in Paris by the ministries of higher education of France, Germany, Italy, and the United Kingdom. In the latter document the four ministries demonstrated alliance on the opportunity "to realise a common European area of higher education, where the national identities and the communal interests could be integrated and mutually enforced to the benefit of Europe, the students, and more in general, the European citizens". At the conclusion they hoped that "other EU member countries and other European countries" would join in the project.

The Bologna Process has led to structural reforms, particularly in Germany and Italy, and the development of matriculation agreements and a rising transnational flow of students. The European Commission has launched a potentially significant effort to create an European research area with ambitious goals for exceeding the U.S. in non-defense R&D. This document initiated an important and presently irreversible process to harmonize the various European systems of higher education. Objectives of the Bologna agreement is to allow the Europe of solve a growing number of new and difficult challenges: globalisation, integration of several new members, as well as the transformation of Europe into an economic area founded upon knowledge. In order to successfully confront these challenges, it is of most importance now to encourage scientific and cultural exchanges at all levels and to allow for the maximum mobility of qualified workers, students, and researchers. It is necessary, therefore, to gain harmonization of the university systems that, with respect to the diverse cultures and academic traditions, facilitates the recognition of university qualifications, have the possibility to issue

joint-degree, favours the mobility of students and researchers, and thus enlarges the horizons of the labour market on a European scale. In the Declaration of Bologna, the central role that education holds in the realisation of this project is recognised, as defined in the course of the European Union summit held in Lisbon in 2000 and in Barcelona in 2002. This recognition has the intent to create in Europe within the next decade an economic area more competitive on the global scale and a more dynamic scientific system in the world, with bigger and better employment possibilities and a larger social cohesion. Education, in particular higher education, represents a powerful axis but also the most delicate aspect in this ambitious project. The so-called Bologna Process constitutes without a doubt the principal tool for the attainment of the elevated standards of quality in the sphere of education. The Declaration of Bologna has defined six objectives, to be carried out by 2010.

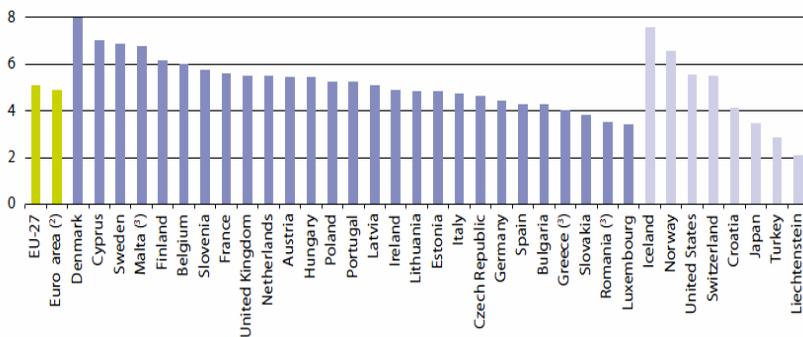
- Adoption of a system of qualification readily legible and compatible, also by means of the implementation of a Diploma Supplement.
- Adoption of a system founded upon a two-cycle system, that is a 1st and 2nd level. Entrance to 2nd level cycle will require the completion of a 1st cycle of study, of whose duration cannot be less than three years.
- Consolidation of a system of academic credits - based on the ECTS system -that can be acquired in diverse disciplinary contexts.
- Promotion of mobility (for students, lecturers, researchers and technical-administrative personnel) by means of removing obstacles for the full exercise of free circulation.
- Promotion of European cooperation concerning the assessment of quality.
- Promotion of an indispensable European dimension of higher education: development of degree plans, cooperation between university institutions, mobility programmes, integrated studies plans, development and research.

Therefore, in conformity to the 1999 reform, in **Italy** the undergraduate studies are organised on a First Cycle: 1st Level

Degree Courses / One-Long cycle 2nd Degree Courses. Undergraduate studies consist in Corsi di Laurea-CL (1st degree courses) aimed at guaranteeing undergraduate students an adequate command of general scientific methods and contents as well as specific professional skills. First degree courses usually last 3 years. The Laurea-L (1st degree) is awarded to undergraduates who have earned 180 credits. Undergraduate students can also apply for Corsi di Laurea Specialistica a ciclo unico - CLSu (One-long Cycle 2nd Degree Courses). For these courses it is necessary to obtain 300 credits - 360 in the case of Medicine. These degrees controlled by the European Union regulations are single cycle degrees, in other words there is not a first level, but the teaching activities are spread directly over 5 or 6 years. Apart from the aforementioned degree courses within the framework of the Bologna Process, undergraduate students can apply for Summer and Winter Schools which are international courses lasting between one and four weeks. They are usually structured as intensive courses on many different subjects designed to match new educational and professional needs. The courses are addressed to undergraduates and young graduates from all over the world and, in some cases, to highly skilled professionals. This educational activity is conceived as an academic meeting point for scholars from all over the world. Here students can enrich their knowledge by attending courses held by lecturers of international repute and, at the same time, share a unique cultural experience simply by mixing with peers from all over the world. In some courses university credits can be earned and grants are available. During the past academic years the Italian University undertook a relevant new planning of all the courses offered, according to the Ministerial Decree 270/04 which will become effective in the academic year 2008/09. The main changes made by DM 270/04 made the following new names for educational qualifications:

- Laurea (L) (1st level Degree)
- Laurea Magistrale (LM) (2nd level Degree)
- Diploma di Specializzazione (DS) (Specialization Diploma)
- Dottorato di Ricerca (DR) (PhD or Research Doctorate)

In **Hungary** and **Croatia** at Zagreb University, the Bologna Agreement is applied (Milisits, 2011, personal communication; Curik, 2011, personal communication).



(1) Refer to the Internet metadata file (http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/tsiir010_esms.htm).

(2) EA-15 instead of EA-16.

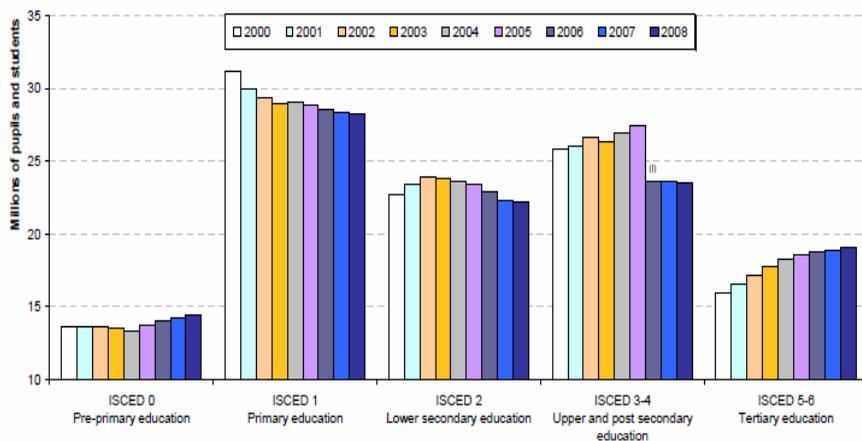
(3) 2005.

Source: Eurostat (tsiir010)

Figure 1. Public expenditure on education, (% of GDP at 2006)

In rough, public expenditure on education in the EU-27 (Figure 1) in 2006 was equivalent to 5.1 % of GDP, while the expenditure of both public and private sources of funds on educational institutions amounted to 5.7 % of GDP. The highest public spending on education was observed in Denmark (8.0 % of GDP), while Cyprus (7.0 %), Sweden (6.9 %) and Malta (6.8 %) also recorded relatively high proportions. Among the countries of Animal Science Days agreement the highest public spending on education was observed in Slovenia, followed by Hungary, Italy and Croatia (Eurostat yearbook, 2010, <http://epp.eurostat.ec.europa.eu>).

Moreover, in the European area, demographic trends in the last three decades reflect reductions in birth rates, that have resulted in the structure of the EU's population ageing and the proportion of those aged under 30 decreasing in the majority of member states (Figure 2). These changes can have a significant impact on human and material resources required for the sound functioning of education systems – such as average class sizes or teacher recruitment strategies.



Flags: (i) See additional information in the country-specific notes at the end of the DIF

Source: Eurostat, Education statistics, UOE data collection. ([educ_ilev](#))

Figure 2. Statistics on education in Europe (EU27) in terms of number of pupils and students by level of education (in millions) from 2000 to 2008.

3. A worldwide comparison at PhD level

In order to compare how nations/states and universities are producing education at high level, in particular at the PhD level (tertiary education), it is important to learn which are the differences among the systems in order to establish collaboration and to transfer ideas at the educational systems. Cyranoski et al. (2011) reported the following differences among countries around the world.

Germany is the country of the progressive PhD, because of the relatively low income of German academic staff that makes leaving the university after the PhD a good option. Germany is Europe's biggest producer of doctoral graduates, turning out some 7,000 science PhDs in 2005. After a major redesign of its doctoral education programmes over the past 20 years, the country is also well on its way for solving the oversupply problem. Traditionally, supervisors recruited PhD students informally and trained them to follow in their academic footsteps, with little oversight from the university or research institution. But, as in the rest of Europe, the number of academic positions available to graduates in Germany has

remained stable or fallen. So, these days, a PhD in Germany is often marketed as advanced training not only for the academic career path, but also for the wider workforce. Universities now play a more formal role in student recruitment and development, and many students follow structured courses outside the lab, including classes in presenting, report writing and other transferable skills. Just under 6% of PhD graduates in science eventually go into full-time academic positions, and most will find research jobs in industry.

Poland have seen dramatic increases. In 1990–91, Polish institutions enrolled 2,695 PhD students. This figure rose to more than 32,000 in 2008–2009 as the Polish government, trying to expand the higher-education system after the fall of Communism, introduced policies to reward institutions for enrolling doctoral candidates.

Despite the growth, there are problems. The country's economic growth has not kept pace with that of its PhD numbers, so people with doctorates can end up taking jobs below their level of expertise. And Poland needs to collect data showing that PhDs from its institutions across the country are of consistent quality, and are comparable with the rest of Europe. In Poland, as in most countries, unemployment for PhD holders is below 3%. Often, PhD holders are not always satisfied with their jobs than those without the degree.

England has embarked on a large range of higher education reforms intended to expand access, bolster accountability measures, and revise funding including the inclusion of post-graduate fees and new infusion of money from the national government.

Australia has experimented also with post-graduate fees and has adjusted to lower levels of government funding by embarking upon a major mission of expanding revenue through accommodation of students from other Asian countries.

Japan has accomplished major systematic change in the organization and funding of its public universities. Japan, in term of PhD educational level, is a system in crisis, indeed, of all the countries in which to graduate with a science PhD, Japan is arguably one of the worst. In the 1990s, the government set a policy to triple the number of postdocs to 10,000, and stepped up PhD recruitment to meet that goal. The policy was meant to bring Japan's science capacity up to match that of the West but is now much criticized because, although it quickly succeeded, it gave little thought to where all those postdocs

were going to end up. Academia doesn't want them: the number of 18-year-olds entering higher education has been dropping, so universities don't need the staff. Neither does Japanese industry, which has traditionally preferred young, fresh bachelor's graduates who can be trained on the job. The science and education ministry couldn't even sell them off when, in 2009, it started offering companies around ¥4 million (33,600 Euro or 47,000 US\$) each to take on some of the country's 18,000 unemployed postdoctoral students (one of several initiatives that have been introduced to improve the situation). It's just hard to find a match between postdoc and company, and this means that there are few jobs for the current crop of PhDs. Among the 1,350 awarded doctorates in natural sciences in 2010, just over half (746) had full-time positions lined up by the time they graduated. But only 162 were in the academic sciences or technological services; of the rest, 250 took industry positions, 256 went into education and 38 got government jobs. **China** has announced an ambitious plan for the creation of twenty world-class research universities on a par with MIT. China might be identified with the following slogan: "quantity outweighs quality". The number of PhD holders in China is going through the roof, with some 50,000 people graduating with doctorates across all disciplines in 2009, and by some counts it now surpasses all other countries. The main problem is the low quality of many graduates: many PhD supervisors are not well qualified, the system lacks quality control and there is no clear mechanism for weeding out poor students. China's booming economy and capacity building has absorbed PhD holders into the workforce. At the present, it is a lot easier to find a position in academia in China compared with the United States and the same is true in industry, but PhD graduates can run into problems if they want to enter internationally competitive academia. To get a position at a top university or research institution requires training, such as a postdoctoral position, in another country. Many researchers do not return to China, draining away the cream of the country's crop. The quality issue should be helped by China's efforts to recruit more scholars from abroad. More institutions are now starting to introduce thesis committees and rotations, which will make students less dependent on a single supervisor in a hierarchical system. **Singapore** and **Taiwan** likewise have each undertaken a major upgrading of their premier universities. The Slogan for Singapore

might be the following “Growth in all directions”. The picture is much brighter in Singapore. Here, the past few years have seen major investment and expansion in the university system and in science and technology infrastructure, including the foundation of two new public universities. This has attracted students within and outside the country. Enrolment of Singaporean nationals in PhD programmes has grown by 60% over the past five years, assessing to 789 in all disciplines, and the country has actively recruited foreign graduate students from China, India, Iran, Turkey, eastern Europe and farther afield. Because the university system in Singapore has been underdeveloped until now, most PhD holders go to work outside academia, but the continued expansion of the universities could create more opportunities.

India, in 2004, produced around 5,900 science, technology and engineering PhDs, now grown to some 8,900 units per year. This is still a fraction of the number from China and the United States, and the country wants many more to match the explosive growth of its economy and population. The government is making major investments in research and higher education, including a one-third increase in the higher-education budget in 2011–12, and is trying to attract investment from foreign universities. The target is that up to 20,000 PhDs will graduate each year by 2020. Those targets ought to be easy to reach: India’s population is young, and undergraduate education is booming. But there is little incentive to continue into a lengthy PhD programme, and only around 1% of undergraduates currently do so. Most are intent on securing jobs in industry, which require only an undergraduate degree and are much more lucrative than the public-sector academic and research jobs that need postgraduate education. Indian students “don’t think of PhDs now, not even master’s; a bachelor’s is good enough to get a job”. Even after a PhD, there are few academic opportunities in India, and better-paid industry jobs are the major draw. For many young people intent on postgraduate education, the goal is frequently to go to the United States or Europe.

Egypt is the Middle East’s powerhouse for doctoral studies. In 2009, the country had about 35,000 students enrolled in doctoral programmes, up from 17,663 in 1998. But funding has not kept up with demand. The majority comes through university budgets, which are already strained by the large enrolment of students in

undergraduate programmes and postgraduate studies other than PhDs. Universities have started turning to international funding and collaborations with the private sector, but this source of funding remains very limited. The deficit translates into shortages in equipment and materials, a lack of qualified teaching staff and poor compensation for researchers. It also means that more of the funding burden is falling on the students. The squeeze takes a toll on the quality of research, and creates tension between students and supervisors. The doctorate is frequently a means of climbing the civil-service hierarchy, but those in the private sector often complain that graduates are untrained in the practical skills they need, such as proposal writing and project management. Egyptian PhD holders also struggle to secure international research positions. Generally, the overall quality of Egyptian research papers is “mediocre”. But, the political upheaval in the region this year could bring a change: many academics who had left Egypt are returning, hoping to help rebuild and overhaul education and research. Few PhDs are trained elsewhere in the Middle East, less than 50 a year in Lebanon.

Several world-class universities established in the **oil-rich Gulf States** in recent years have increased demand for PhD holders. So far, most of the researchers have been ‘imported’ after receiving their degrees from Western universities, but Saudi Arabia and Qatar in particular have been building up their infrastructure to start offering more PhD programmes themselves.

Ukraine's academic promotion system, twenty years after independence, is trying to stay competitive in scientific areas such as aerospace, applied mathematics, theoretical physics, energy and organic farming, but its higher education is still tied to the old Soviet system. Reforms are based towards meeting international standards, hence with original research with external peer review, promote autonomy under democratic and competent management, and support academics by encouraging them to stay at home (Corobets, 2011).

In the **United States**, reforms are focused largely on ways to cope with declining rates of public investment in public higher education and rising fees and rising operating costs, while maintaining access. There is interest also in incorporating new accountability schemes.

Businesses are becoming more international in their activities and are thereby altering their traditional patterns of investing in research, including corporate funding of basic and applied university-based

research. Many large high technology firms are shifting portions of their R&D investment to new research centres in China, India, and other countries: regions where research expertise and talent are being aggressively nurtured. In the United States the main aspect is the supply versus demand. The United States is second only to China in awarding science doctorates (it produced an estimated 19,733 in the life sciences and physical sciences in 2009) and production is going up. However, this trend is not considered positive, because of the proportion of people with science PhDs who get tenured academic positions in the sciences has been dropping steadily and industry has not fully absorbed the slack. The problem is most acute in the life sciences, in which the pace of PhD growth is biggest, yet pharmaceutical and biotechnology industries have been drastically downsizing in recent years. In 1973, 55% of US doctorates in the biological sciences secured tenure-track positions within six years of completing their PhDs, and only 2% were in a postdoc or other untenured academic position. By 2006, only 15% were in tenured positions six years after graduating, with 18% untenured. Recently, several analyses of market suggest that more doctorates are taking jobs that do not require a PhD and the critical point is that the government spend a lot of money training these students and then they go out and get jobs that they're not well matched for. Nevertheless, production of US doctorates continues apace, fuelled by an influx of foreign students. Some universities are now experimenting with PhD programmes that better prepare graduate students for careers outside academia.

In the **ASD's countries**, following the Eurostat statistics (Eurostat yearbook, 2010, <http://epp.eurostat.ec.europa.eu>) the students in the tertiary education level (ISCED 5-6), including PhD students, in all disciplines were in 2007 a total of 2,722,000 (Figure 3), with an weighted average of 2.48% involved in agricultural and veterinary programs, with a increment of +17% from 2002 to 2007.

In conclusion, this international analyses provide that the world is producing more PhDs than ever before. The number of science doctorates earned each year grew by nearly 40% between 1998 and 2008, to some 34,000, in countries that are members of the Organisation for Economic Cooperation and Development (OECD). The growth shows no sign of slowing: most countries are building up their higher education systems because they see educated workers as

a key to economic growth. But in much of the world, the PhD graduates may never get a chance to take full advantage of their qualifications. Supply has outstripped demand and, although few PhD holders end up unemployed, it is not clear that spending years securing this high-level qualification is worth it for a job as, for example, a high-school teacher. Most PhD education programs are conform to a model in which education is a process of cloning that trains students to do what their mentors do, and the clones are now vastly outnumbering their mentors. In other countries, such as China and India, the economies are developing fast enough to use all the PhDs they can crank out and more, but the quality of the graduates is not consistent. Only a few nations, including Germany, are successfully tackling the problem by redefining the PhD as training for high-level positions in careers outside academia. Therefore, optimization of collaboration models among countries, between public and private companies, and between academic and industry sectors are needed.

In other terms, in the next future, to improve the high educational level around the world, we need to evolve the Adam Smith's concept, who, in the economic contest, said that a group can obtain the best result when each member does what is best for itself, with the more complete theory of John Nash (Nash 1950a; 1950b), who, instead, formulated that the best result is achieved when each member does what is best for themselves and for the group, according the equilibrium theory of Nash; therefore, more collaboration is expected and hoped, in the near future.

4. Models of collaboration

To apply possible models to optimize the collaboration across ASD's countries and international systems and institutions of higher education, first of all it is useful to clarify the definition of the term "collaboration". Collaboration has a variety of definitions and names, but is generally meant as the cooperative way that two or more entities work together towards a shared goal. Collaboration among individuals with shared goals in professions such as mental health and education has been studied (Kabler and Genshaft, 1983; Moriarty, 2000; Smith, Frey and Tollefson, 2003), as collaboration within and among individuals in the development of small groups (Tuckman, 1965; Tuckman and Jensen, 1977). Additionally, some

researchers have explored the specific nature of successful relationships within school and business partnerships (Ash, 1989; Del Pizzo, 1990; Kysiak, 1986; Rockefeller, 1986). However, a comprehensive theory of collaboration within the types of shared organizational efforts (Gajda, 2004) formed through grant funded initiatives and other public service efforts has not been presented in the literature.

Preliminary models of collaboration within service-oriented strategic alliances have been presented in the literature (Bailey and Koney, 2000; Gadja, 2004; Hogue, 1993; Peterson, 1991). These models commonly focus on stages of collaboration through which inter-agency initiatives might move. Gadja argues that groups will pass from lower to higher stages of collaboration before they can be effective. These stage theories describe levels of collaboration with the lowest level being little or no collaboration and the highest levels being full collaboration or, ultimately, complete unification. The models differ on the number of stages, the range of levels included, and the definitions of various stages, but they have much in common. Peterson (1991) proposed three types of agency interaction-cooperation, coordination, and collaboration.

Though described by Peterson as distinct states of interactions among agencies and not offered as a strict series of stages, in Gadja's (2004) review of Peterson's model, they are presented as a three point continuum. These categories are differentiated based on the degree of member autonomy associated with each. Hogue (1993) suggested five levels of community linkage- networking, cooperation or alliance, coordination or partnership, coalition, and collaboration. The levels differ by purpose, the structure of decision making, and the nature of leadership. Bailey and Koney (2000) offered a model similar to these with four steps, ending with complete unification-cooperation, coordination, collaboration, and coadunation (which means having grown together). A five-stage model consistent with previous stage approaches was suggested by Gadja. The level of integration model has five ordered steps- networking, cooperating, partnering, merging, and unifying. The steps differ on purpose, tasks and organizational strategies, leadership and decision-making and type and frequency of communication.

Plenary lectures

Figure 3. Statistics on students in tertiary education, 2007.

	Total number of students in tertiary education (1 000)	of which, studying (%)						Services
		Humanities & arts	Social sciences, business & law	Science, math. & computing	Engin., manuf. & construction	Agricul. & veterinary	Health & welfare	
EU-27	18 877	13.1	33.9	10.5	14.0	1.9	12.6	4.1
Belgium	394	10.9	29.5	6.5	9.5	2.5	19.4	1.9
Bulgaria	259	7.9	44.0	5.1	19.7	2.5	6.2	8.0
Czech Republic	363	8.7	28.6	8.7	14.2	3.7	11.9	4.1
Denmark	232	15.3	29.0	8.7	10.1	1.5	22.0	2.2
Germany	2 279	15.5	27.4	15.3	15.5	1.5	14.5	3.1
Estonia	69	11.4	39.8	9.9	13.1	2.4	8.3	8.1
Ireland	190	14.7	22.0	11.0	10.3	1.2	13.1	4.9
Greece	603	13.5	31.8	13.6	17.0	5.8	9.6	3.1
Spain	1 777	10.3	31.6	10.5	17.6	2.0	11.7	5.6
France	2 180	16.0	35.6	12.4	12.8	1.1	15.1	3.4
Italy	2 034	15.3	35.6	7.9	15.6	2.3	12.9	2.7
Cyprus	22	9.5	49.9	11.9	6.8	0.1	6.1	6.1
Latvia	129	7.2	53.7	5.1	10.4	1.1	6.3	5.6
Lithuania	200	7.1	42.8	5.9	18.2	2.2	8.4	3.1
Luxembourg (*)	3	8.2	45.2	8.4	15.0	0.0	0.4	0.0
Hungary	432	8.6	40.6	6.9	11.5	2.7	8.8	9.1
Malta	10	16.2	35.4	10.3	7.9	0.1	17.6	1.9
Netherlands	583	8.5	37.5	6.5	8.1	1.2	16.9	6.2
Austria	261	15.4	36.5	12.0	12.7	1.1	7.9	1.8
Poland	2 147	10.2	40.3	9.5	12.6	2.2	6.1	5.6
Portugal	367	8.5	32.0	7.3	22.3	1.9	16.5	5.7
Romania	928	9.9	51.0	6.2	17.2	2.7	5.6	4.3
Slovenia	116	7.8	41.7	5.6	16.7	3.2	7.2	9.5
Slovakia	218	6.2	29.4	8.9	15.7	2.6	16.2	5.5
Finland	309	14.6	22.7	11.2	25.4	2.2	13.7	4.9
Sweden	414	12.5	26.3	9.4	16.1	0.9	17.7	2.0
United Kingdom	2 363	17.1	26.9	13.4	8.4	0.9	16.0	3.1
Croatia	140	9.7	41.7	7.7	15.7	3.8	7.0	10.2
FYR of Macedonia	58	11.2	38.0	9.4	14.8	3.2	9.0	4.3
Turkey	2 454	6.2	48.7	7.5	13.1	3.7	5.6	3.8
Iceland	16	14.6	38.5	7.9	7.7	0.6	12.7	1.5
Liechtenstein	1	0.7	74.3	0.0	22.9	0.0	2.1	0.0
Norway	215	11.6	32.3	8.8	7.0	0.8	19.8	4.0
Switzerland	213	12.7	37.0	10.5	13.2	1.1	11.0	3.5
Japan	4 033	15.7	29.1	2.9	15.8	2.2	12.5	5.7
United States	17 759	10.6	27.3	8.9	6.7	0.6	13.9	5.1

(*) Refer to the Internet metadata file (http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/en/educ_esms.htm).

(†) 2006.

Source: Eurostat (tps00062 and educ_enr15)

The measurement levels of collaboration among partners might be defined as a level of cooperation that involves teamwork, communication and consideration. The five stages of Hogue's (1993) Levels of Community Linkage model might be the most relevant framework. The taxonomy of Hogue use a 0 to 5 scale with 0 indicating "no interaction at all" and 5 indicating the collaboration level (Table 1). An example of Hogue's taxonomy was applied at the co-ordination committee level of the ASD, by email, using a survey. The results obtained between the components of ASD agreement outlined that the preferred types of cooperation should cover the flow Erasmus, the PhD schools and research groups. The cooperation in education is considered very important, if not extremely important among ASD's partners, with the interest on application of EU projects such as FP7 (Seventh Framework Programme), INTERREG and LLP (Lifelong Learning Programme) calls. The outcome of the questionnaires was particularly poor at the level of cooperation joint courses, exchange of teachers and students.

5. Conclusions

The main criticism for the actual university is that it is inflexibly compartmentalized in disciplines and departments. This compartmentalization stifles innovation among researchers and promotes parochialism in the curricula. When we focus too much on parochialism and competition we don't consider the quality and relevance of the work. That's where cooperation enters. A good educational program is not those which has won on other programs, but the educational program that helps to solve real problems and create a new generation that will optimize the collaboration. Cooperation stimulates bringing different areas together, and creating more dialog between inside and outside the academy.

Expertise, of course, is essential to the advancement of knowledge and to society; but in far too many cases, specialization has led to areas of research so narrow that they are of interest only to other people working in the same fields, subfields or sub-subfields. Many researchers struggle to talk to colleagues in the same department, and communication across departments and disciplines can be impossible. If doctoral education is to remain viable in the twenty-first century, universities must tear down the walls that separate fields, and establish programmes that nourish cross-disciplinary

Table 1. Descriptions of the different levels of collaboration.

5 Levels of Collaboration and Their Characteristics					
	Networking 1	Cooperation 2	Coordination 3	Coalition 4	Collaboration 5
Relationship and Characteristics	<ul style="list-style-type: none"> -Aware of organization -Loosely defined roles -Little communication -All decisions are made independently 	<ul style="list-style-type: none"> -Provide information to each other -Somewhat defined roles -Formal communication -All decision are made independently 	<ul style="list-style-type: none"> -Share information and resources - Defined roles -Frequent communication -Some shared decision making 	<ul style="list-style-type: none"> -Share ideas -Share resources -Frequent and prioritized communication -All members have a vote in decision making 	<ul style="list-style-type: none"> -Members belong to one system -Frequent communication is characterized by mutual trust -Consensun is reached on all decisions

investigation and communication. They must design curricula that focus on solving practical problems, such as providing clean water to a growing population.

For example, to successfully confront the challenges we face in providing clean water to people in need, we will require collaboration and expertise from such diverse fields as economics and geology, political science and chemistry.

It is important to realize that problems will never be solved as long as each institution continues to act independently. The difficulties are systemic and must be addressed comprehensively and cooperatively, so seeking competitive advantage and financial gain will be made possible by alliances with the private sector that the universities will need to create.

We need for collaboration and the curricular reform in agreement with all partners.

To facilitate change, universities should move away from excessive competition fuelled by pernicious rating systems, and develop structures and procedures that foster cooperation. This would enable them to share faculty members, students and resources, and to efficiently increase educational opportunities. Institutions wouldn't need a department in every field, and could outsource some subjects. Tools as teleconferencing and internet mean that cooperation is no longer limited by physical proximity. Therefore, our colleges and universities must find a way to promote forms of creative specialization not threatened by generalized collaboration. It should be better to call for opening up our schools to more flexible networks of research and learning. The mission of universities should be providing students with specialized skills that include a thirst and capacity for innovative collaboration beyond the disciplines and departments that taught the skills in the first place. Fulfilling this mission will sustain higher education, but more importantly it will shape the culture of the future.

The technologies that have transformed financial markets and the publishing, news and entertainment industries are now changing the education system. In the coming years, growing global competition for the multibillion-dollar education market will increase the pressure on our universities, just when public and private funding is decreasing. Although significant change is necessary at every level of higher education, it must start at the top, with a reform of PhD

programmes in almost every field. The future of our young people, our countries and, indeed, the world depends on how well we meet this challenge on the collaborations in the field of Education at University level.

6. References

Cyranoski, D., et al. (2011). The PhD Factory. *Nature*, 472, 276-279. **Corobets, A.** (2011). Modernize Ukraine's university system. *Nature* 473:154. **Ash, A.M.** (1989). Inter-organizational relations and effectiveness in school-business partnerships. Unpublished doctoral dissertation, University of Miami. **Bailey, D.** and Koney, K. (2000). Strategic alliances among health and human services organizations: From affiliations to consolidations. (Abridged). Thousand Oaks, CA: Sage. **Del Pizzo, M.T.** (1990). A naturalistic study of the salient themes of a school/business partnership. Unpublished doctoral dissertation, West Virginia University. **Gajda, R.** (2004). Utilizing collaboration theory to evaluate strategic alliances. *American Journal of Evaluation*, 25(1), 65-77. **Hogue, T.** (1993). Community-based collaboration: Community wellness multiplied. Bend, OR: Chandler Centre for Community Leadership. Retrieved April, 21, 2004 from <http://crs.uvm.edu/ncco/collab/wellness.html>. **Kabler, M.** and Genshaft, J. (1983). Structuring decision-making in multidisciplinary teams. *School Psychology Review*, 12(2), 150-159. **Kysiak, R.C.** (1986). Role of the university in public-private partnerships. *Proceedings of the Academy of Political Science*, 36(2), 47-59. **Moriarty, M.L.** (2000). Attitudes on collaboration in education: A pilot study. Unpublished manuscript, University of Kansas. **Nash, J.F.** (1950a). Equilibrium Points in N-Person Games. *Proceedings of the National Academy of Sciences of the United States of America* 36 : 48-49. **Nash, J.F.** (1950b). The Bargaining Problem, *Econometrica* 18 : 155-162. **Peterson, N.L.** (1991). Interagency collaboration under Part H: The key to comprehensive, multidisciplinary, coordinated infant/toddler intervention services. *Journal of Early Intervention*, 15(1), 89-105. **Rockefeller, D.** (1986). Ingredients of successful partnerships: New York City case. *Proceedings of the Academy of Political Science*, 36(2), 122-154. **Smith, S. J.**, Frey, B.B., and Tollefson, N. (2003). A collaborative cohort approach to teacher education: Modelling inclusive practices. *Action in Teacher Education*, 24(1), 55-61. **Tuckman, B.W.** (1965).

Developmental sequence in small groups. *Psychological Bulletin*, 63(6), 384-399. **Tuckman, B.W.** and Jensen, M.A.C. (1977). Stages of small group development revisited. *Group and organizational Studies*, 2(4), 419-427.

ACKNOWLEDGEMENTS – The present review was possible thank to the collaboration of the coordination committee of the Animal Science Days, and for the valuable advices of Enrico Zanetti, Enrico Sturaro and Denis Pretto of the Department of Animal Science of the University of Padova (Italy).

ANIMAL PRODUCTION AS A PERSPECTIVE FOR QUADRILATERAL COLLABORATION

Kresimir SALAJPAL*, Danijel KAROLYI

Faculty of Agriculture, University of Zagreb

*Corresponding author: Kresimir SALAJPAL, +38512394038; +3852393947;
ksalajpal@agr.hr*

Summary

This paper gives the main characteristics of animal production in Croatia and analyzes its competitiveness as a basis for possible collaboration between the countries of Quadrilateral in the field of animal production. It describes the current state and recent trends in milk and meat production and their perspective after Croatian accession to EU. Particular emphasis is put on the analysis of trade relations with countries of the Quadrilateral. The main characteristic of Croatian livestock production is the small average farm size and low productivity what could be the main reasons for a general inefficient domestic livestock production and dependence on import of both live animals and animal products (milk and meat). In order to increase the competitiveness of Croatian farmers' and meet the increasing for milk and meat additional farm concentration and the cooperation of small holders as well as a more effective use of local resources such as land, labour and livestock tradition is necessary. In addition, after EU accession Croatian livestock sector can expect further integration in international trade and better opportunities for export (e.g. elimination of protective tariffs) on common EU market, especially with regard to products that are lacking in EU (e.g. beef). In this way collaboration between countries of Quadrilateral through development and implementation of new technologies can contribute to a better use of specific national resources and better production efficiency.

Key words: Quadrilateral countries, livestock, milk and meat production, collaboration

1. Introduction

The question about possibility of collaboration between the Croatia, Hungary, Italy and Slovenia (Quadrilateral countries) in the field of animal production became more interesting in context of Croatian accession to EU in the near future (2013). In negotiations with the EU Croatia has secured a period of 7 years of adjustment for its agriculture. Among the changes in agricultural legislations and system of subsidies, it could be expected that current structural changes in animal production will be intensively progress. After a big reduction of animal production during the early 1990s as results of the war and economic transition, a trend of recovery in livestock production could be seen after the year 2000 (World Bank, 2011). In the past ten years Croatian government made immense efforts to increase the livestock production through the two models: “Capital investments model” and “Favourable credit programmes” associated with operational programmes for the development in each sub-sector of animal production. The intention was to create sustainable farms with market-oriented production which could be competitive on the common European market. In addition, the biggest efforts have been put into the adjustment and implementation of EU standards of “Good Agricultural Practices” related to animal production, health and welfare. Therefore, the experiences of both new (Hungary, Slovenia) and old (Italy) EU members in the implementation of these standards could be of interest for Croatia. The collaboration between institutions involved in higher education such as Universities could help in a better exchange of existing experiences. In addition, it is expected that animal scientists in collaboration with extension services could contribute to the transfer and implementation of new technologies in agricultural sector. In some cases business cooperation between companies involved in animal production sector (e.g. trade of material resources such as farm equipment, animal feed, live animals and genetic material, etc.) is not associated with professional support what could result in the absence of expected production results.

The aim of this overview is to give the main characteristics of animal production in Croatia and to analyze its competitiveness and possibilities for collaboration between the countries of Quadrilateral in the field of animal production.

2. Main characteristics of livestock production in Croatia

Agriculture is important part of Croatian economy with the 6.8 % share of GDP, which is higher in comparison to other Quadrilateral countries (4.2 % in Hungary and 2 % in both Italy and Slovenia; Eurostat, 2007a). In terms of total agricultural output, in 2007 livestock production contributed 46.7% to total agricultural output from which the milk production accounts for about 13.2% (or 28.3 % of animal output). In meat production sector, pig meat contributed 12.2 % to total agricultural output (or 26.1 % of animal output). The other three meat sub-sectors, important in terms of output: poultry, beef and sheep and goat in the same year contributed 7.6 %, 7.3 % and 1.5 % of total agricultural output or 16.3 %, 15.6 % and 3.2 % of animal output, respectively.

As can be seen in Table 1, in 2007 Croatia had 1 202 thousands ha of total utilized agricultural area (UAA), of which 847 thousands ha arable land and 270 thousands ha permanent pastures. In general, Croatia has an unfavourable structure of agricultural holdings with a lot of small family farms. The average farm size in Croatia of 5.6 ha is the smallest among the Quadrilateral countries (Table 1). On the other hand, the density of livestock populations on UAA expressed through livestock density index (LDI), as indicator of land resources available for livestock production in Croatia (0.73) is at the average EU-27 level (0.78; Eurostat, 2011). With regard to human population pressure, Croatia has similar livestock units per capita (around 0.20) as Hungary, but higher than in Italy. In both indicators of livestock production density, Slovenia has the highest figures among Quadrilateral countries (Table 1). As can be seen in Figure 1, Slovenia and Italy has the greatest contribution of cattle to total livestock units, while in Croatia and, especially in Hungary, the pigs and poultry together dominate. In 2010, Croatia had about 444 thousand cattle, 1 230 thousands pigs, 9 470 thousands birds and 630 thousands sheep. In the livestock sector, small production units predominate, especially for cattle, pig, sheep and goat keeping. Poultry production on the other hand is characterised by large-scale production units (for poultry meat and eggs).

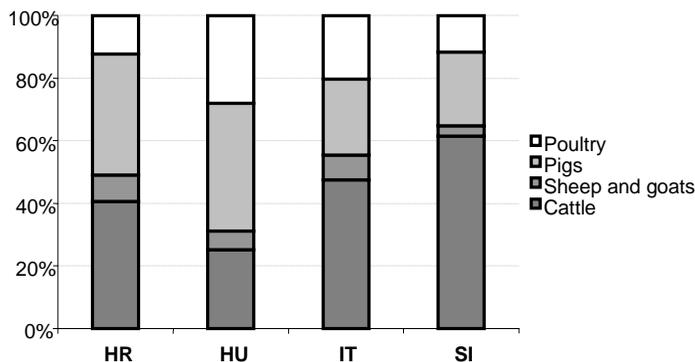


Figure 1. Contribution of species to total livestock unit, 2007 (Equidae, rabbits, beehives and others not included)

3. Milk production – current state and perspective for quadrilateral collaboration

With annual production of 769 thousands tons in 2010 Croatia meet up about 90 % of its demands for milk and milk products. The current level of milk production is a result of significant changes in dairy sector in the past 20 years. Firstly, a negative trend from 1990 to 2000 reduced milk production by 30 %. The main reasons for such fall in milk production were war (1991-1995) and economical changes which resulted in depopulation of 1/3 mainly rural territory of Croatia, along with the collapse of the common market, decrease in the purchasing power and changes in the land ownership. In addition, more than 1.5 million hectares of agriculture land, mostly pasture, disappeared in the past 15 years. Then, from 2000 milk production grew to reach the highest level of 834 thousand tons in 2007 (increase of 35 %). The reasons for this increase were high price of milk and secured buy-off from dairies as well as availability of favourable Governmental crediting programmes through the “Operative program for development of cattle production in Croatia”. The intention of this program was to achieve milk production of 1 200 thousand tons (or 100 % self-sufficiency at average domestic consumption of 200 kg per capita and consumption of milk by tourist) and to obtain 208 500 calf for fattening through to building of 7 220 new dairy farms adaptation of 6 000 existing dairy farms and

228 new cow-calf production farms. The program did not give expected results and was extinct in 2009. Only 190 farms were realised (of 7220 planned) and only 14 % of available budget was utilised. As the main reasons for absence of expected results could be insufficient assimilative capacity of farmers (small farms limited in agricultural land, unfavourable age and educational structure, lack of knowledge about dairy farm management), administrative limitations for re/construction of farms, limit capacity of extension services as well as the drop of milk prices and economic crisis in the 2008 and 2009.

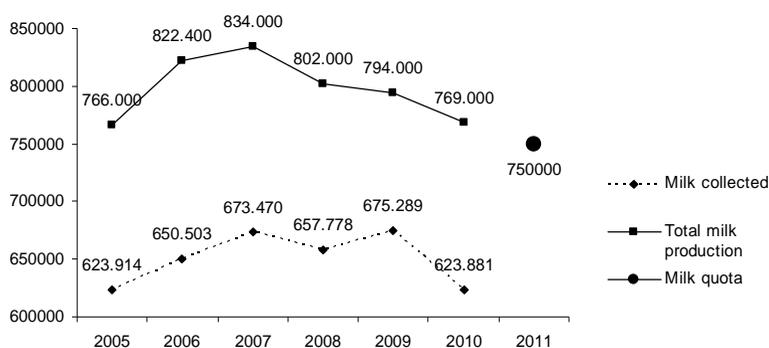


Figure 2. Trend in milk production in Croatia (2005-2010),
Source: Croatian bureau of statistic, 2010; Croatian agriculture agency, 2010

As shown in Figure 2, after 2007 a negative trend in milk production was observed again, with the reduction in total milk production for about 3-4 % per year. These trends in milk production could be a direct consequence of reduction in number of dairy farms and total number of cows. With respect to the structure of milk production (number of farms and dairy cows, herd size, milk yield) Croatia showed similar trends as other transitional countries. A constant reduction in the number of dairy farms and cows were observed while the milk yield and herd size were increased (Figure 3).

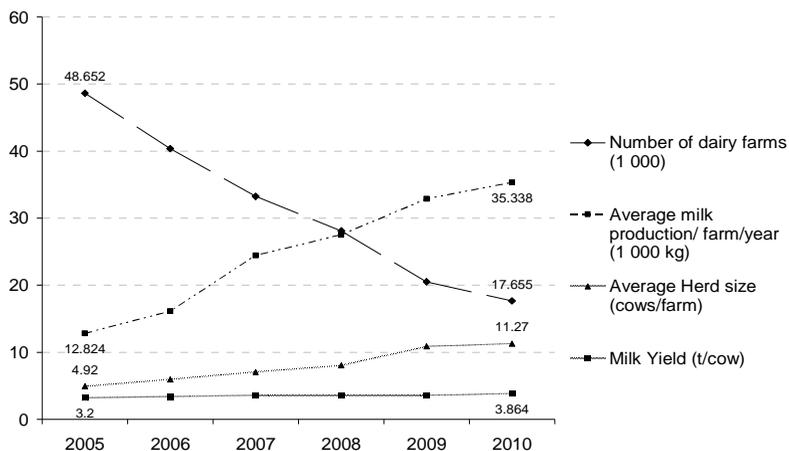


Figure 3. Characteristics of milk production in Croatia (2005-2010),
Source: Croatian bureau of statistics, 2010; Croatian agriculture agency, 2010

In the past five years the number of dairy cows was reduced for about 40 thousands (or 17 %) and number of commercial dairy farms by about 30 thousands (or 64 %). Similar trend continued in first 6 month of 2011, in which the number of commercial dairy farms was reduced by additional 1850 farms or 11 % (unpublished data, Croatian agriculture agency). At the same time the average milk production per cow, number of dairy cows per farm and average milk production per farm and year were increased by 17 %, 56 % and 64 %, respectively. In comparison to other Quadrilateral countries, in 2010 Croatia had the smallest amount of collected milk per cow (3 100 kg vs. 4 700, 5 520 and 6 070 kg in Slovenia, Hungary and Italy, respectively). The average number of cows per farm and annually collected milk per farm in 2007 was 7.0 and 24.4 tons vs. 6.1 and 27.6 tons in Slovenia, 21.8 and 119 tons in Hungary and 29.3 and 163.5 tons in Italy. Together with the concentration of milk production to larger production units the share of collected milk by dairies is in constant growth. In the year 2010 dairy companies collected 81.1 % of total milk production, while 18.9 % was used on the farm as animal feed or was directly sold to consumers as fresh milk or milk products. This is at the similar level as in Hungary (80.0

%, 2009) and Slovenia (82.7 %, 2009) but lower than in Italy (92.4 %, 2009). In the past ten years the amounts of milk in Croatia dairies varies with changes in domestic production and increased demand of domestic inhabitants and tourist. Negative trends in the past three years resulted in decrease in processing of domestic milk and increase in import of fresh milk and milk products. In 2010, the collected cows milk decreased by 7.6 % or 52 thousands tons in comparison to 2009, while the import of the whole milk by dairies increased by 36.7 % or 16.3 thousands tons. In the year 2010 about 685 million kg of raw milk was processed, of which about 50 % was utilised as drinking milk. However, trend of increasing processing of milk into cheese and fermented products was observed in recent years. Similar changes were observed in the structure of milk consumption. The consumption of fresh milk was reduced while the consumption of fermented milk products and cheese was increased. With consumption of about 9 kg of cheese per capita Croatia is under the EU-27 average (18 kg) as well Italy (22.6 kg) but at similar to Hungary (9.0 kg) and Slovenia (11.4 kg; Table 3).

In the past five years the annual import of milk and milk products was about 150 million tons (expressed as milk equivalents), while export vary between 75 to 105 million tons. Therefore Croatia is net importer of milk and dairy products with self-sufficiency rate between 85 % (2004) and 95 % (2007). In the structure of import dominate cheese, followed by fresh and condensed milk and fermented products. While import of cheese significantly increased in recent years due to low prices of cheese on the European market and liberalization of Croatian market toward EU, import of fresh milk was mostly dependent by domestic production. With reduction of milk production in the past two years import of fresh milk is rapidly growing (36.7 % in 2010). Ten years ago Hungary and Slovenia were important suppliers of fresh milk and fermented milk products with share of 40 % in total import of milk and dairy products. However, import of fresh milk and fermented dairy products from these countries rapidly decreased in the recent years. In 2010 the main part

Table 1. Utilized agriculture area (UAA, 1 000 hectares)

	Total	Arable land	Pasture (permanent)	Crops (permanent)	UAA per agricultural holding	LDI	LSU per capita
HR	1 202	847	270	80	5.6	0.73	0.20
HU	4 229	3 553	504	155	6.8	0.56	0.21
IT	12 744	6 939	3 452	2 323	7.6	0.77	0.17
SI	489	173	288	26	6.5	1.13	0.27

Source: EUROSTAT, 2011a; LDI – livestock density index calculated as livestock units (LSU) per hectare of UAA

Table 2. Milk production, 2009 (1 000 tonnes) Source: EUROSTAT, 2011a

	Total	Cows' milk		Ewes milk	Goats milk	Buffalos milk	Total milk production per capita(kg)	Total milk production per UAA (kg)
		Production	Collected (%)					
HR	848	826	81.7	8	14		197.6	707
HU	1 762	1 758	80.0	1	3		175.4	417
IT	12 193	11 364	92.4	600	34	195	204.0	957
SI	629	626	82.6	1	2		310.4	1 342

Table 3. Supply balance sheet and indicators of milk production (2009)*

	HR	HU	IT	SI
Gross human consumption (1 000 t)				
Drinking milk	-	728.89	3 533.42	-
Cheese	38.48	90.24	1 329.77	22.74
Butter	7.43	7.54	169.43	2.42
Gross human consumption per capita (kg)				
Total milk	217.52	175.59	256.1	240.00
Drinking milk	-	72.67	60.12	-
Cheese	8.67	9.0	22.63	11.39
Butter	1.67	0.75	2.88	1.21
Degree of self-sufficiency (%)				
Drinking milk	-	89.33	87.37	-
Cheese	82.14	78.96	82.96	104.75
Butter	103.6	83.12	69.93	181.26

Source: EUROSTAT, 2011a; * 2007 or 2008 data have been used to replace data that were not available for 2009.

Plenary lectures

Table 4: Supply balance sheet and indicators of meat production, 2009 (1 000 t)

	HR*	IT	HU	SI**
Gross indigenous production (GIP)	301.5	4245.0	910.0	158.9
Cattle	47.2	855.0	45.0	41.0
Pigs	137.1	1605.0	423.0	45.4
Sheep and goats	6.4	41.0	7.0	2.0
Horses	0.11	11.0	1.0	0.5
Poultry	93.0	1249.0	388.0	62.6
GIP per capita (kg)	68.0	70.3	90.9	77.8
Cattle	10.6	14.2	4.5	20.1
Pigs	30.9	26.6	42.2	22.2
Sheep and goats	1.4	0.7	0.7	1.0
Horses	0.02	0.2	0.1	0.2
Poultry	21.0	20.7	38.7	30.7
Consumption per capita (kg)	87.6	90.0	80.0	94.2
Cattle	14.7	23.0	3.0	20.5
Pigs	44.8	38.0	44.0	40.5
Sheep and goats	2.1	1.0	0.0	1.0
Horses	0.0	1.0	0.0	0.2
Poultry	22.3	19.0	29.0	28.1
Degree of self-sufficiency (%)	77.8	78.0	114.0	82.6
Cattle	72.6	61.0	163.0	98.1
Pigs	69.0	70.0	96.0	54.8
Sheep and goats	69.1	49.0	639.0	97.5
Horses	138.8	23.0	209.0	145.9
Poultry	93.9	108.0	134.0	109.1

Source EUROSTAT, 2011b; * Source: MAFRD, 2008; data for 2008; **Source SORS, 2011.

Table 5: Trade balance in live animals, 2010

HR		Heads	\$ (1000)	Origin / destination (%)		
				HU	IT	SI
Import						
Cattle						
	Total	140 123	87 283	11.4	0.01	
	Breeding animals	5 764	10 970	0.6	1.4	
	Calf for fattening	89 853	56 854	3.1		
	Cattle for slaughtering	44 506	19 459	29.7		
Swine						
	Total	626 126	42 989	4.6		
	Breeding animals	806	456			
	Piglets for fattening	615 831	41 608	4.3		
	Pigs for slaughtering and other	9 489	925	25.8		
Sheep and goats						
	Total	56 248	3 873	27.7		
	Lamb (fattening and slaughter)	54 281	3 735	27.8		
	Other	1 967	137	25.0		
Poultry	Total	1 180 118	2 787	28.0	1.7	6.3
Export						
Cattle						
		9 496	14 550			
Swine						
		23 818	3 967			
Sheep and goats						
		510	37 391			
Poultry						
		2 036 030	1 448			

Source: Croatian chamber of economy, 2011

Table 6: Trade balance in animal products, 2010

HR		Tons	\$ (1000)	Origin / destination (%)		
				HU	IT	SI
Import						
Milk	Total milk and products	77 354	119 961	11.7	0.8	3.4
	Fresh and fermented products	64 274	62 378	14.0		2.9
	Cheese	11 955	51 909	0.3	5.1	6.7
	Butter	1 125	5 673		0.1	0.2
Meat	Total meats and offal	72 377	199 011	2.8	3.3	1.2
	Beef	8 381	29 529			
	Pork	39 755	105 822	4.5	0.5	0.1
	Sheep and goat	1 542	9 726			
	Poultry	15 176	33 025	1.4	0.9	4.4
	Salted/dried meat	2 346	15 446	0.04	88.8	7.4
Eggs		2 812	9 253	10.1	1.9	20.5
Export						
Milk	Total milk and products	51 884	62 693		0.4	8.6
	Fresh and fermented products	47 272	40 448		0.4	8.9
	Cheese	2 132	10 122			8.3
	Butter	1 252	6 281			6.0
Meat	Total meats and offal	11 000	31 692	0.1	10.6	2.4
	Beef	5 594	17 815		20.7	
	Pork	912	2 572	1.2		
	Poultry	3 754	10 137			7.1
	Salted/dried meat	83	790		7.2	1.2
Eggs		663	2 658	12.4		3.3

Source: Croatian chamber of economy, 2011

in import of fresh milk had Bosnia and Herzegovina (75 %) while Hungary and Slovenia participated only with 14 % and 2.9 %, respectively. Cheese is mostly imported from EU countries, especially from Germany. About 5.1 % and 6.7 % of imported cheese originated from Italy and Slovenia, respectively. Croatian export of milk and dairy products is mostly oriented on traditional markets in Bosnia and Herzegovina (75 %), Slovenia (8.6 %) and other ex-Yugoslavia countries. With 217.5 kg of total milk consumption per capita (Eurostat, 2007b) and current negative trend in milk production as well as assigned milk quota of 750 million tons after accession to EU, the dependence of Croatia to import of milk and dairy products is expected to increase.

4. Meat production – current state and perspective for quadrilateral collaboration

When it comes to meat production sector, as visible from Figure 4, Croatia has biggest production within pig-production sub-sector which in period 2000-2008 averagely accounted for about 45.7 % of gross indigenous production (GIP). It is followed by the production of poultry (31.9 % of GIP), beef (14.2 % of GIP) and sheep and goat meat (2.3 % of GIP). Domestic production of meat during this period varied between 272 thousand and 308 thousand tons, with an overall increase of 10.8 % (% change 2000-2008). The highest relative increase was observed in beef and sheep/goat sub-sectors with 13.5 %, while for the pigs and poultry the increase was 11.6 % and 9.0 %, respectively. The increasing trend in meat production can be partly interpreted as an overdue recovery of the livestock sector after the post-war years and the result of Government development programmes for cattle and pig production in order to increase production, and to improve production systems by establishing new and modern farms, capable of fully meeting the conditions necessary for the achievement of a standardized product quality, environmental standards and animal welfare. Also, a recent sector investments of several large livestock breeders and feedstuff producers (e.g. Belje d.d., Žito d.o.o.) that have the important role in the market, particularly in pork and beef sector, have significantly contributed to positive trends.

In comparison to other Quadrilateral countries (Table 4), Croatia has the lowest per capita overall production of meat, amounting 68 kg,

which is the slightly lower than in Italy (70 kg), while the highest per capita meat production has Hungary (91 kg), followed by Slovenia (78 kg). Per capita production is an indication of how far domestic production goes to meet a national per capita consumption and hence elimination of imports. Among the different kind of meat, Hungary is leading in per capita production of both pork (42 kg) and poultry (39 kg), followed by Croatia in production of pork (31 kg) and Slovenia in production of poultry (31 kg). Slovenia also leads in per capita production of beef (20 kg).

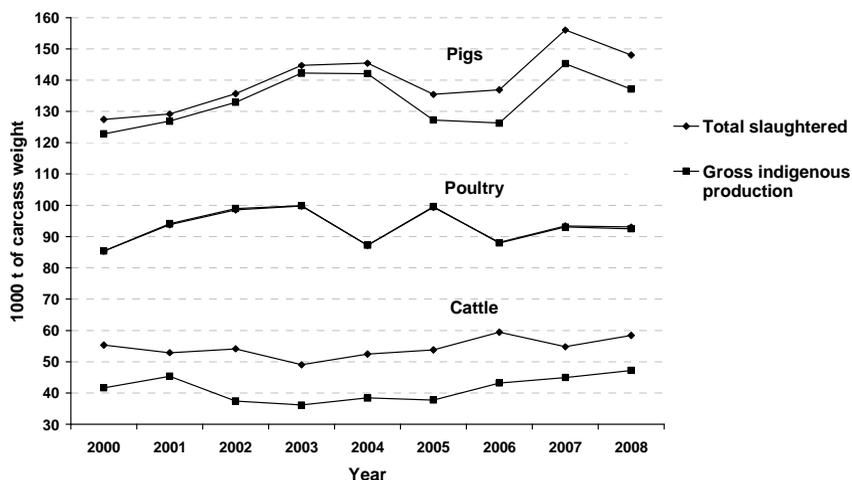


Figure 4: Trends in meat production in Croatia (2000-2008), Source: MAFRD, 2008; Gross indigenous production: net production plus external trade balance (exports minus imports) of all animals of the species.

Consumption of meat in Croatia (Figure 5) increases steadily in recent years, reaching 88 kg / per capita in 2008 (23.8 % change 2000-2008), of which pork with 44.8 kg / per capita (32.4 % increase) and poultry with 22.3 kg / capita (17.3 % increase) are decisive in consumption. The per capita consumption of beef (14.7 kg) and sheep and goat (2.1 kg) meat also rose (11.1 % and 30.9 % change, respectively). However, the increase in meat consumption was never fully supplied by domestic production. The overall level of self-sufficiency for meat in 2008 was 77.8 %, with the highest rate

for poultry (93.4 %), followed by beef (72.6 %) and pork and sheep/goat meat (both around 69 %). The steepest drops in the level of self-sufficiency as a result of increase in consumption in recent years were observed for pork, poultry and sheep and goat meat.

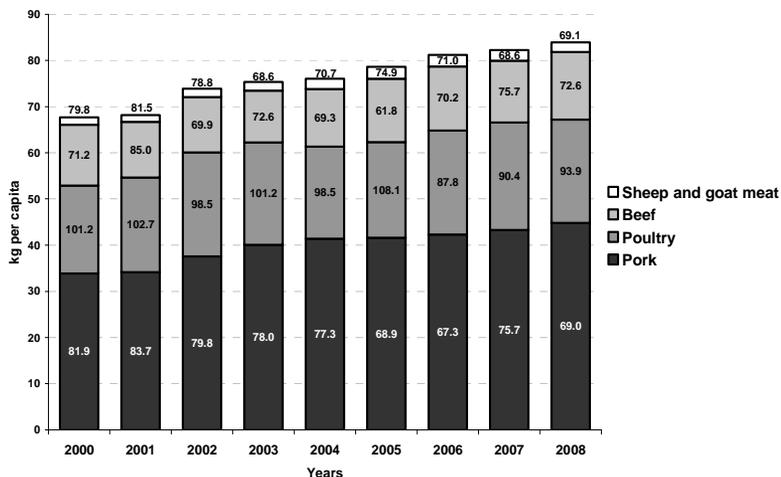


Figure 5: Per capita meat consumption and the levels of self-sufficiency (%) in Croatia (2000-2008), *Source: MAFRD, 2008*

As could be seen from Table 4, the current meat consumption per capita in Croatia is approaching the level in Slovenia (94 kg) and Italy (90 kg), and is higher than in Hungary (80 kg). The pork is the most frequently consumed meat in all Quadrilateral countries, with the highest average consumption in Croatia and Hungary (around 45 kg). The consumption of poultry meat is the highest in Hungary (29 kg), where it partly replaced the post-accession fall in other meat (mainly pork) consumption, and in Slovenia (28 kg). The highest consumption of beef is in Italy (23 kg) and Slovenia (21 kg); while consumption of other kind of meats is generally low (sheep and goat) or related to specific traditional diet (e.g. use of horse meat in Italy). In relation to the degree of self-sufficiency for meat in other Quadrilateral countries, only Hungary with the overall rate of 114 % meets its own needs, while neither Slovenia nor Italy covers all the domestic needs with the self-sufficiency rate of 83 % and 78 %, respectively.

respectively. The widest gaps are present in Slovenia for pork (55 %) and in Italy for all kind of meats (beef 61 %, pork 70 %, sheep/goat 49 % and horse meat 23 %), except poultry.

As a result of deficits for all type of meats, Croatia is a growing importer of both live animals and meat. From live animals, the most significant (> 90 %) is import of pigs and cattle, which grew strongly from less than 20 thousand in 2000 to nearly 30 thousand tons in 2008, mainly due to large increase in import of live pigs (Figure 6). In recent years, almost entire import of both live pigs and cattle originate from the EU. In the same period, the import of meat has increased around 2.5 times, from an initial 30 thousand tons to nearly 80 thousand tons. The most imported meat is pork, mainly from EU, followed by poultry and beef, which are imported more equally from both EU and other countries (Figure 7).

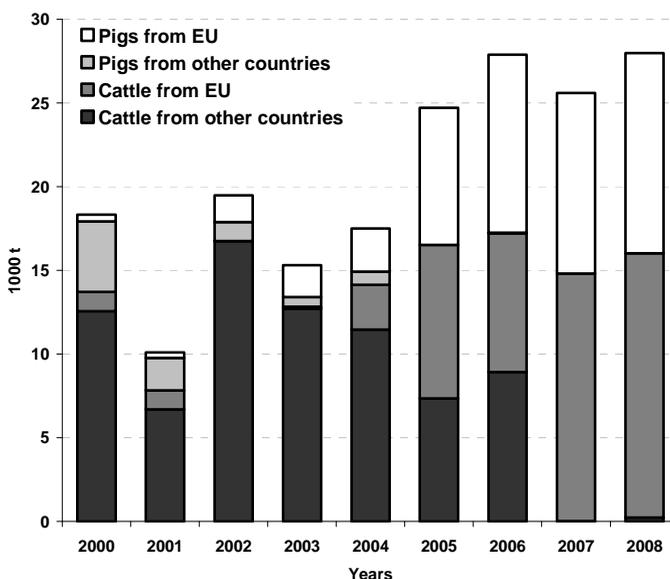


Figure 6: Import of live pigs and cattle in Croatia (2000-2008), *Source: MAFRD, 2008*

Export of live animals is small but has increased over the observed period from initial 0.5 thousand to more than 6 thousand tons in

2008, of which about 73 % was live cattle, 16 % pigs, 10 % poultry and 1 % horses (data not shown). The export of both pork and poultry meat is also growing; however, a significant proportion of export on the EU market is present only for poultry and beef (Figure 8). The European market is particularly deficient in beef and it is estimated that import of beef in EU-27 will reach the level of 741 thousand tons until 2014 (EC, 2007).

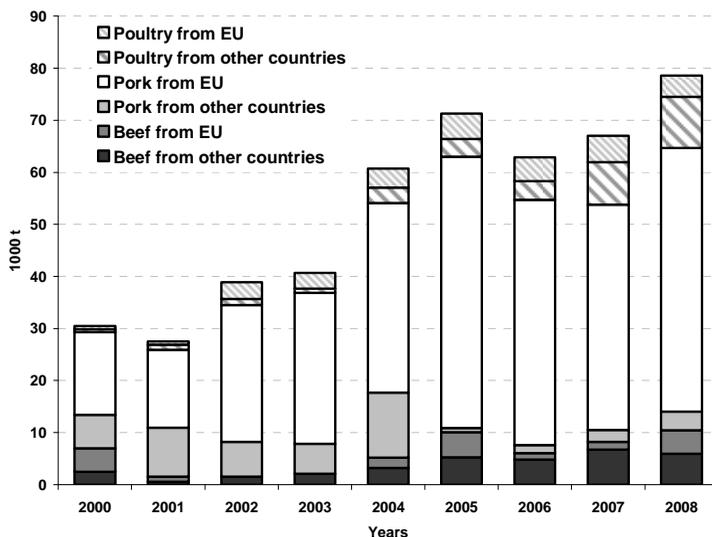


Figure 7: Import of meat in Croatia (2000-2008), *Source: MAFRD, 2008*

More detailed data about the trade balance in live animals and livestock products between Croatia and other Quadrilateral countries in 2010 are given in Tables 5 and 6. As could be seen (Table 5), from the total number of cattle imported in Croatia (around 140 thousands) 11.4 % originated from Hungary. The largest share in total import had calves for fattening (about 64 %) and cattle for slaughtering (32 %), of which 3.1 % and 29.7 %, respectively, were imported from Hungary. From other cattle categories, Croatia has also imported 4 % breeding animals, of which 1.4 % was of Italian and 0.6 % of Hungarian origin. The same year, Croatia imported around 626 thousands of live pigs, of which 4.6 % came from Hungary. By far the most important category were piglets for fattening (around 98 %),

of which 4.3 % originated from Hungary, along with 25.8 % of imported live pigs for slaughtering. In 2010, Hungary was also one of the most important exporters of live poultry and sheep (mainly lambs for fattening and slaughter) on Croatian market with the share of about 28 % for both in total import of 1 200 thousands and 56 thousands heads, respectively. In addition, 6.3 % of the total number of imported live poultry originated from Slovenia and 1.7 % from Italy. In the same period, Croatia sold abroad (mainly to ex-Yugoslavia markets and Middle East countries) approximately 9.5 thousands cattle, 24 thousands pigs and 2 million birds. However, there was no export to other Quadrilateral countries, except for a minor trade of horses (640) for slaughtering in Italy.

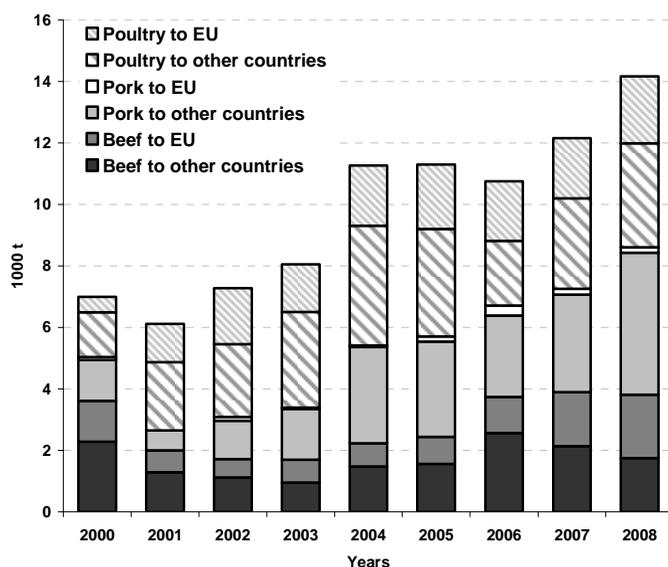


Figure 8: Export of meat from Croatia (2000-2008), *Source: MAFRD, 2008*

As regards to meat trade balance (Table 6) in 2010, Croatia imported more than 72 thousands tons of meat, of which around 7 % (principally pork, poultry and dried/salted meats) originated from other Quadrilateral countries (3.3 % from Italy, 2.8 % from Hungary and 1.2 % from Slovenia). From nearly 40 thousands tons of

imported pork, Hungary supplied 4.5 %, Italy 0.5 % and Slovenia 0.1 %. In addition, from around 15 thousands tons of poultry meat imported, 4.4 % originated from Slovenia, 1.4 % from Hungary, and 0.9 % from Italy. In total import of salted/dried meats (around 2.3 thousand tons), Italy was by far the most important partner with the 88.8 % share in overall trade, followed by Slovenia with the 7.4 % share.

At the same year, export of Croatian meat amounted 11 thousand tons, of which about 13 % end on markets of other Quadriateral countries, mostly Italy and Slovenia. The most significant is export of beef in Italy (20.7 % of total 5.6 thousand tons) and to lesser extent the export of poultry meat in Slovenia (7.1 % of total 3.7 thousand tons). These two countries were also an export destination for a minor quantities of salted/dried meats, while Hungary was destination for some pork (1.2 % of total 0.9 thousand tons).

5. Conclusions

The small average farm size and low productivity are the main reasons for a general inefficient Croatian livestock production and dependence on import of both live animals and animal products (milk and meat). Milk production as one of the most important part of Croatian agriculture sector is undergoing structural changes (farm concentration, higher milk yield, new technologies). Despite of that the production continuously decreasing, the foreign trade balance of milk and milk products deteriorating and the rate of self-sufficiency falling. With the current negative trend in milk production it can not be expected to meet the allocated quota after Croatia EU accession in near future. An important supplier of milk and dairy products for Croatia are countries of Quadriateral (Slovenia and Hungary for fresh milk and Italy for cheese). The consumption of milk and dairy products slightly increased in recent years and reached the similar level as in Hungary but it is still lower than in Slovenia and Italy. The main lag remains in consumption of cheese and fermented dairy products. Meat production, a traditionally vital part of Croatian livestock and agricultural sector, shows a slight upward trend of recovery during the last decade. Pig and poultry are decisive in both production and consumption. However, in general meat production does not meet the rising domestic demands and Croatia is a net importer of live animals and meat from both EU and other countries.

In relation to Quadrilateral partners, Croatia still lags in overall meat production per capita and the rate of self-sufficiency, especially in relation to Hungary (for pork and poultry) and Slovenia (for beef and poultry). In Croatian import, both Hungary and Slovenia account for a notable proportion of live birds and poultry meat, and Hungary alone is also a significant partner in import of live cattle, lambs, pigs and pig meat. In addition, Italy and to lesser extent Slovenia, are the most important foreign suppliers of salted/dried meats. On the other hand, Croatian export to other Quadrilateral countries is less significant, except for export of beef to Italy, which accounts for a substantial part of domestic meat export. As preferential quota for export on EU market (9.4 thousand tons) has not yet been reached, the national beef producers will have good opportunity for export expansion in coming years, especially regarding traditional Italian market.

With the EU accession, Croatian livestock sector (both milk and meat) can expect further integration in international trade and better opportunities for export (e.g. elimination of protective tariffs) on common EU market, especially with regard to products that are lacking in EU (e.g. beef). However, with accession, Croatian milk and meat producers will be additionally exposed to fierce competition within the EU market, and further import penetration and consequent market share reduction could be expected as well. To improve the competitiveness of Croatian farmers' additional farm concentration and the cooperation of small holders as well as a more effective use of local resources such as land, labour and livestock tradition is necessary. Collaboration between countries of Quadrilateral through development and implementation of new technologies can contribute to a better use of specific national resources and better market position on common EU market.

6. References

Croatian agriculture agency (2010). Annual report - cattle breeding, <http://www.hpa.hr>. **Croatian bureau of Statistic** (2010). Statistical Yearbook of the Republic of Croatia, <http://www.dzs.hr>. * **Croatian chamber of economy** (2011). Trade balance sheet – livestock production. **EC** (2007). European Commission, Directorate General for Agriculture and Rural Development. Prospects for agricultural markets and income in the European Union 2007-2014.

EUROSTAT (2011a). Pocketbook. Food: from farm to fork statistics 2011 edition, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-32-11-743/EN/KS-32-11-743-EN.PDF. **EUROSTAT** (2011b). Statistics database, Meat balance sheet (apro_mt_bal), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=apro_mt_bal&lang=en. **EUROSTAT** (2007a). Statistic database, Economic Accounts for Agriculture, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database. **EUROSTAT** (2007b). Statistic database, Milk and milk products (apro_mk), <http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do>. **MAFRD** (2008). Ministry of Agriculture, Fisheries and Rural Development. Study of production and consumption balance sheet and self-sufficiency assessment of Agri-Food products (internal data). **SORS** (2011). Statistical office of the Republic of Slovenia. Supply balance sheet of agricultural products, Rapid Reports No 7. **World Bank** (2011). Livestock production index, <http://data.worldbank.org/indicator/AG.PRD.LVSK.XD>.

ACKNOWLEDGEMENTS – Authors are grateful to Željka Mesić (Faculty of Agriculture Zagreb) and Jasminka Dukić (Croatian chamber of economy) for their kind assistance and data provided.