



HAL
open science

Compte-rendu du Workshop international sur les normes et les marchés de la viande

Linda Farmer, Kurt Straif, Stefaan de Smet, Vincenzo Russo, Rainer Roehe,
Aidan Moloney, Jean-François J.-F. Hocquette, David Farrell, Rod
Polkinghorne, Jerzy Wierzbicki, et al.

► **To cite this version:**

Linda Farmer, Kurt Straif, Stefaan de Smet, Vincenzo Russo, Rainer Roehe, et al.. Compte-rendu du Workshop international sur les normes et les marchés de la viande. *La revue française de la recherche en viandes et produits carnés*, 2018, 33, pp.2-8. hal-01997273

HAL Id: hal-01997273

<https://hal.science/hal-01997273>

Submitted on 20 Sep 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Compte-rendu du second congrès intitulé « Qualité durable de la viande bovine en Europe »

Compte-rendu du second congrès de Février 2017 intitulé « Qualité durable de la viande bovine en Europe » qui s'adressait à la fois à des scientifiques et des professionnels

Mots-clés : Viande bovine, Qualité

Auteurs : Linda Farmer¹, Kurt Straif², Stefaan De Smet³, Vincenzo Russo⁴, Rainer Roehle⁵, Aidan Moloney⁶, Jean-François Hocquette⁷, David Farrell¹, Rod Polkinghorne⁸, Jerzy Wierzbicki⁹, Tim Searchinger¹⁰, Dequan Zhang¹¹, Ettore Capri¹², Paolo Ferrari¹³, Jonathan Birnie¹⁴, Valeria Viganò¹⁵, Ciara K. McDonnell¹⁶, Phil Hadley¹⁷, Terence Hagan¹, Declan Troy¹⁶

¹ Agri-Food and Biosciences Institute, Newforge Lane, Belfast, UK ; ² International Agency for Research on Cancer, Lyon, France ; ³ LANUPRO, Ghent University, Belgium ; ⁴ Dept. of Agricultural and Food Sciences, School of Agriculture and Veterinary Medicine, University of Bologna, Via Fanin, 50, 40127 Bologna, Italy ; ⁵ Scotland's Rural College (SRUC), Roslin Institute Building, Edinburgh EH25 9RG, UK ; ⁶ Teagasc, Animal & Grassland Research and Innovation Centre, Grange, Dunsany, Co. Meath, Ireland ; ⁷ INRA, VetAgro Sup, UMR1213, Recherches sur les Herbivores, Theix, 63122 Saint-Genès-Champagnelle ; ⁸ Birkenwood Pty Ltd, 431 Timor Rd, Murrurundi, NSW 2388, Australia ; ⁹ Polish Beef Association, ul. Smulikowskiego 4, 00-389 Warsaw, Poland ; ¹⁰ Princeton's Woodrow Wilson School of Public and International Affairs; consultant to the World Bank on Climate Smart Agriculture; Senior Fellow at the World Resources Institute ; ¹¹ Institute of Food Science and Technology, Chinese Academy of Agricultural Sciences, Beijing, China ; ¹² Catholic University of the Sacred Heart, Piacenza, Italy ; ¹³ Research Centre for Animal Production, Reggio Emilia, Italy ; ¹⁴ Dunbia, Dungannon, Northern Ireland ; ¹⁵ Sealed Air Packaging, via Trento, 7, 20017 Passirana di Rho (MI), Italy ; ¹⁶ Teagasc Food Research Centre, Ashtown, Dublin 15, Ireland ; ¹⁷ AHDB Beef and Lamb, Agriculture & Horticulture Development Board.

* E-mail de l'auteur correspondant : linda.farmer@afbini.gov.uk

Cet article est une compilation des résumés des conférences présentées au second congrès intitulé « Qualité durable de la viande bovine en Europe » organisé par l'AFBI qui s'est tenu les 1^{er} et 2 Février 2017 à Milan. Les présentations sont sur le site <https://www.afbini.gov.uk/milan-programme-and-workshop-presentations-2017>.

Résumé :

Le « Agri-Food and Biosciences Institute (AFBI) » a récemment organisé un workshop européen à Milan pour discuter des principaux défis auxquels la filière viande bovine est confrontée, avec plus de 80 personnes issues de la communauté scientifique ou de la filière au niveau européen. La réunion a été organisée par l'AFBI avec l'Université de Milan et financée par le « UK Science and Innovation Network ». L'objectif global de la réunion était de renforcer les liens et les échanges de connaissances entre les scientifiques et les professionnels de la filière à travers l'Europe sur les principaux défis auxquels est confrontée la filière viande bovine. Quatre sessions avec des courtes conférences ont porté sur quatre sujets importants concernant la viande bovine (nutrition humaine, qualité sensorielle, environnement et bien-être animal, valeur ajoutée le long de la filière) tandis que deux ateliers ont permis aux participants de discuter des questions soulevées et de faire part de leurs commentaires. Les conférenciers issus de la communauté scientifique ou de la filière de différents pays d'Europe, des États-Unis, de Chine et d'Australie ont abordé un large éventail de sujets. Cet article présente un résumé de ces présentations et des résultats des ateliers.

Abstract: Report of the workshop “Sustainable beef quality for Europe II – A workshop for industry and scientists”

The Agri-Food and Biosciences Institute (AFBI) recently convened a European Workshop in Milan to discuss some of the key challenges facing the beef industry, with more than 80 people from the beef industry and research communities across Europe attending. The meeting was organised by AFBI with the University of Milan, funded by the UK Science and Innovation Network. The overall goal of the meeting was to strengthen links and exchange knowledge between scientists and industry representatives across Europe on some of the key challenges facing the beef industry. Four sessions of short talks addressed four key topics (Beef and Human Health, Eating Quality, Environment and welfare, Adding value throughout the supply chain), while two extended workshops provided delegates the opportunity to discuss the issues raised and contribute their comments. Expert speakers from research and industry from Europe and also USA, China and Australia covered a wide range of topics. This article presents a summary of these presentations and the outcomes of the workshops. Presentations are available on the following link <https://www.afbini.gov.uk/milan-programme-and-workshop-presentations-2017>.

INTRODUCTION

The European Union (EU) is the world's third largest producer of beef (13.0%) after the USA (19.2%) and Brazil (16.3%), producing 7.7 million tons of carcasses per year. Beef production contributes to the economy, social life, culture and gastronomy of European countries.

The European beef industry is currently facing unprecedented challenges, with questions relating to environmental impact, authenticity of beef, nutritional benefits and consistency of eating quality. These have the potential to affect the whole industry but especially its farmers. It is therefore essential to bring the beef industry together to spread best practice and better exploit research in order to address these challenges, maintain, and develop an economically viable and sustainable European beef industry. An international meeting was organized in Milan on Wednesday 1st and Thursday 2nd February 2017 to discuss some of these key challenges facing the beef industry.

This meeting was organized by Dr Linda Farmer of the Agri-Food and Biosciences Institute (AFBI), Prof Antonella Baldi (University of Milan) and Dr Laura Nuccilli of the British Embassy in Rome. It was sponsored by UK Science & Innovation Network. The aim was to continue the dialogue, commenced at the first meeting organized by the same people (Farmer *et al.*, 2016), between all those with an interest in the

beef industry across Europe into the future, so that an informed and consolidated approach can be taken to the industry's challenges.

More than 80 people attended the meeting, with industry and research well represented. The workshop included short presentations on topics of relevance to the competitiveness and sustainability of European beef. It was organized in five sessions: 1) Beef and Human Health, 2) Update on Eating Quality, 3) Beef, environment and welfare, 4) Adding value throughout the supply chain, and 5) Workshop findings and Future.

Participants were also involved in two workshops which asked "How can the industry help to ensure that beef has a positive nutritional impact?" (Workshop 1) and "How should the industry manage the environmental impact of beef?" (Workshop 2).

Finally, a summary was provided of a project aiming to further foster the links between industry and researchers associated with the beef industry, which has been submitted for funding as an EU thematic network under Horizon 2020. If successful, it is hoped that "Beef2Compete" will build on the foundations laid in this workshop and in the previous one (Farmer *et al.*, 2016).

SESSION 1: BEEF AND HUMAN HEALTH

This session comprised five presentations.

First, Dr Kurt Straif (WHO International Agency for Research on Cancer, France) gave a presentation entitled: "WHO view of red meat and human health – what are the risks?"

In October 2015, an International Agency for Research on Cancer (IARC) Monographs Working Group of independent international experts assessed the carcinogenicity of the consumption of red meat and processed meat (Bouvard *et al.*, 2015). Red meat refers to unprocessed mammalian muscle meat – e.g. beef, veal, pork, lamb – including that which may be minced or frozen. Processed meat refers to meat that has been transformed through salting, curing, fermentation, smoking or other processes to enhance flavour or improve preservation. Meat curing and smoking can result in formation of carcinogenic chemicals including N-nitroso-compounds (NOC) and polycyclic aromatic hydrocarbons (PAH). High-temperature cooking by pan-frying, grilling, or barbecuing produces high amounts of carcinogens including heterocyclic aromatic amines (HAA) and PAH. More than 800 epidemiological studies, including large cohorts in many countries, from several continents, with diverse ethnicities and diets, were assessed. A meta-analysis of colorectal cancer in 10 cohort studies reported a statistically-significant dose-response relationship with a 17% increased risk (95% CI 1.05-1.31) per 100 g/day of red meat and an 18% increase (95% CI 1.10-1.28) per 50 g/day of processed meat. The Working Group classified consumption of processed meat as "carcinogenic to humans" (Group 1) based on sufficient evidence for colorectal cancer. A positive association was found between consumption of processed meat and stomach cancer. Consumption of red meat was classified as "probably carcinogenic to humans" (Group 2A), based on substantial epidemiological data showing limited evidence for colorectal

cancer and on strong mechanistic evidence; in addition there was also limited evidence for pancreatic and prostate cancer.

Then, Prof. Stefaan De Smet (Ghent University, Belgium) discussed the mechanisms and mitigation regarding meat consumption and cancer (De Smet and Vossen, 2016).

As said above, a working group of IARC recently performed a hazard analysis of the carcinogenicity of red and processed meat consumption and classified processed meat as 'carcinogenic to humans' and red meat as 'probably carcinogenic to humans' for colorectal cancer, suggesting that the future role of meat in a healthy diet should be critically considered (Bouvard *et al.*, 2015). It is argued that having more insight in the mechanisms of the association offers opportunities for mitigation. There is now evidence for a critical role of heme iron in this association through catalysis of the formation of N-nitroso-compounds and lipid oxidation products and a possible direct cytotoxic effect (Bastide *et al.*, 2011). There are a couple of other mechanisms that may contribute to the association but these are not specific to meat, such as the formation of heterocyclic amines when cooking at high temperatures, polycyclic aromatic hydrocarbons after grilling over direct flame or smoking of cured meats, secondary bile acids and protein fermentation products (Demeyer *et al.*, 2016). Other potential mechanisms need further investigation. Mitigation options may be taken at the level of meat processing or meal composition and preparation. A protective effect has been demonstrated for the dietary supplementation with calcium and tocopherol, and has been suggested for polyphenols. Much research still needs to be done on this topic (Demeyer *et al.*, 2016). It is advocated that the benefits and risks associated with red and processed meat consumption should not necessarily cause dilemmas, if these meats are consumed in moderate amounts as part of balanced diets.

The third presentation by Vincenzo Russo, Dario Rossi, Leonardo Nanni Costa and Erminio Trevisi from University of Bologna and from Università Cattolica Sacro Cuore, Piacenza, Italy was entitled “How much meat do we eat?”.

The knowledge of meat consumption is crucial to set production and meat supply policies, to compare eating habits with other countries, to assess the nutritional status of a population and to study the relationship between diet and health. In recent years, interest in these aspects strongly increased because epidemiological studies suggested a possible association between high consumption of meat and risk of several forms of cancer as well as metabolic and cardiovascular diseases. Meat consumption is often estimated by methods that are inappropriate because they do not represent the real amount of meat eaten. The meat really consumed may be lower than the apparent amount available for consumption calculated by the food supply balance sheets (FBS, Food Balance Sheet) because it depends on the magnitude of wastage and losses at slaughter, during storage, in household, in dish preparation, during cooking and as plate-waste. Therefore, a method for estimating the real consumption in Italy of beef and other types of meat was developed. This method was based on the same methodology used for calculating the apparent consumption by FBS but it estimated the consumption in term of fresh meat rather than equivalent carcass weight. Fresh meat was defined as meat without bones, cartilage, ligaments, tendons and fascia, lymph nodes and blood vessels and deprived of separable fat with a knife. It was determined for each of the different cattle categories through cutting tests and experts opinion. Conversion coefficients in consumable fresh meat of carcasses, quarters, cuts and all meat products imported and exported were calculated. Applying these factors to the data of annual surveys on domestic slaughter and to the import-export balance made by Italian Statistic Institute (ISTAT), the availability of fresh beef consumable in Italy was obtained. Subtracting wastes and scraps occurring at the level of retail and consumption, the real annual national consumption of beef in Italy was calculated. Dividing by the number of residents in Italy in the same year, the real per capita consumption of beef was obtained. In 2014, it represented approximately 51% of the apparent consumption calculated by the supply balance sheet.

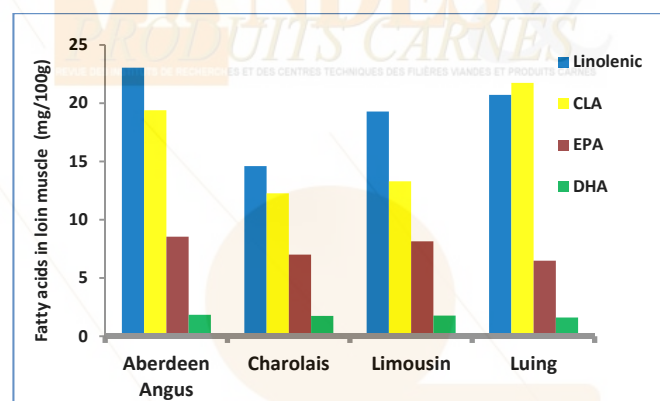
Thereafter, Rainer Roehle, Dave W. Ross, Carol-Anne Duthie and Lucy Coleman from Scotland’s Rural College (SRUC), Edinburgh, UK gave a talk entitled “Genetics and nutritional quality of beef”.

Meat from beef cattle is a very tasty source of nutrition, supplying high quality protein, various vitamins and minerals, bioactive substances and antioxidants associated with human health. However, beef has a high concentration of saturated fatty acids (SFA), which are associated with obesity in humans, a main risk factor for cardiovascular disease. In contrast, beef also contains healthy polyunsaturated fatty acids (PUFA) such as omega-3 fatty acids, which are essential for human nutrition. Omega-3 fatty acids have been shown to provide a wide range of health benefits, in particular in reducing the risk of cardiovascular disease. Breeding for increased omega-3 fatty acids is one option to increase the healthiness of beef. The differences of PUFA between breeds, as presented in Figure 1, are an indication for their genetic determination.

Heritabilities estimated for these PUFA were 0.30 ± 0.15 , 0.46 ± 0.17 , 0.74 ± 0.18 and 0.28 ± 0.15 for α -linolenic,

conjugated linoleic (CLA), eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids, respectively. Genetic improvement is permanent, cumulative and can potentially spread over the entire population and has been shown to be highly cost-effective. However, the high costs of measurements of fatty acids of meat by chemical analysis have prevented the inclusion of these traits in genetic improvement programmes, which need a large number of phenotypic records in order to be reliable. Visible and near infrared reflectance spectroscopy has been shown to be able to accurately estimate fatty acids (R^2 up to 0.76, Prieto *et al.*, 2011).

Figure 1: Mean polyunsaturated fatty acids in the loin muscle in different breeds



Ruminal biohydrogenation of diet PUFA affects substantially the fatty acid profile in beef. Therefore, selection of animals providing optimal conditions of rumen microbes (Roche *et al.*, 2016) associated with reduced biohydrogenation would be another approach to increase omega 3 fatty acids in beef.

Lastly, Aidan Moloney from Teagasc (Ireland) discussed on-farm influences on the nutritional quality of beef.

Beef is generally recognised as a good source of protein, minerals and anti-oxidants but there is also a perception that beef is rich in “unhealthy” saturated fatty acids. However, lean beef with less than 4% fat can be considered a low-fat food. The emphasis on decreasing the consumption of saturated fatty is being increasingly questioned, but medical authorities currently advise a decrease in their consumption and an increase in the consumption of monounsaturated and polyunsaturated fatty acids (PUFA). Within the PUFA, increasing the intake of omega-3 fatty acids is particularly encouraged. Conjugated linoleic acid (CLA) is a fatty acid that may protect against cancer and other diseases. Cattle nutrition is the major factor influencing meat fatty acid composition (reviewed by Scollan *et al.*, 2014).

An increase in energy consumption can increase the fat concentration in beef (intramuscular fat or marbling), and this in turn can influence the fatty acid composition independent of the nature of the ration (Moreno *et al.*, 2008). Feeding grass and/or concentrates containing linseed or fish oil, compared to a standard concentrate ration, results in beneficial changes in the omega-3 PUFA and CLA in beef. These benefits can be enhanced further by preventing dietary PUFA from being digested (hydrogenation) in the rumen through feeding ‘protected’ forms of supplement. When rumen-protected PUFA were fed to cattle, the concentration of beneficial omega-3 PUFA was such that the meat complied with the

European Food Safety Authority definition of a “source” of omega-3 PUFA. However, this beef had a shorter shelf-life, indicating that additional dietary anti-oxidants were required in the supplement fed to the cattle or that different packaging methods to reduce the possibility of oxidation, such as vacuum skin packaging or packs containing antioxidants, would need to be used for these cuts. There is considerable

interest in the possible health benefits of grass-fed beef. While the levels of omega-3 PUFA are below the definition of a ‘source’, grass-fed beef can contribute to overall omega-3 consumption. The challenge for the food industry is to develop strategies to market grass-fed beef or omega-3 PUFA/CLA enriched beef as a meat that is more in line with human health requirements than alternative sources.

SESSION 2: UPDATE ON EATING QUALITY

This session comprised four presentations. The first one by Jean-François Hocquette, Sarah Bonny, Rod Polkinghorne, Linda Farmer, Isabelle Legrand, Paul Allen, Jerzy Wierzbicki, Graham Gardner and David Pethick was entitled “Update on a European beef eating quality model”.

The current assessment of beef is far from real consumers' expectations, and no strong relationship is observed between eating quality and price. The aim of this consortium is to create a reliable and consumer-driven prediction model of beef eating quality for Europe, based on the same principles as the Meat Standards Australia (MSA) grading scheme. However, the MSA system needs some adaptations to suit the European beef chain.

Beef carcasses are currently traded based on the compulsory SEUROP grid, which uses visual and/or instrumental assessments to give scores for both muscling and fatness. We found that there was no substantial relationship between the SEUROP system and eating quality. Therefore, the SEUROP grid would have to operate in parallel with an eating quality based grading system (Bonny *et al.*, 2016a).

Additionally, carcasses from entire males and from dairy breeds are important in the European beef industry. These carcass types are under-represented in the MSA model and it is therefore unable to completely explain the differences in eating quality between breeds (dairy, beef, crossbred) and genders (entire males, steers, females). Consequently, a separate adjustment for entire males and dairy breeds is required to accurately predict eating quality for these groups (Bonny *et al.*, 2016b).

It is well established that, as an animal matures, beef quality decreases. In Australia, this is estimated through an assessment of bone maturity called ‘ossification’ whereas the European beef industry has accurate age records available to it. Ossification score is more appropriate for young animals but as animals approach the maximum ossification scores, animal age becomes more appropriate in an eating quality prediction model (Bonny *et al.*, 2016c). This implies that both measures are required to optimise accuracy, an approach that needs to be weighed against the additional cost of assessing ossification whether this is done manually or by some automated vision system.

We also focused on European consumers and their ability to quantify beef eating quality. We observed that there were no major demographic effects on consumer evaluation of eating quality and willingness to pay (Bonny *et al.*, 2017).

These results demonstrate that a beef eating quality grading system, similar in design to the Australian MSA system, is highly applicable to both the European beef industry and the European consumers, despite the need for some adjustments. Further work is needed to determine the optimum statistical model for such a system.

Then, David Farrell and Linda Farmer discussed the question of beef quality measurement and prediction.

Beef is a luxury product, much appreciated by consumers, but there is evidence that it does not always deliver the expected quality (Farmer *et al.*, 2016). This inconsistency of beef quality is not a new problem nor is it unique to Europe. Evidence shows that the EUROP grade, used across Europe as a standard for carcass quality and by which farmers are paid, bears no relationship to the final quality of the meat (Bonny *et al.*, 2016a).

Beef quality is a broad ranging term that includes eating quality, nutritional composition, safety and authentication; this presentation focused on eating quality and nutritional composition. Standardised methods for the measurement of beef quality are well known, however the majority of these methods are destructive and therefore not suitable for “on-line” measurement as desired by industry.

Data from the first Sustainable Beef Quality for Europe Workshop (Farmer *et al.*, 2016) highlighted the urgent need to reduce the inconsistency of beef quality and also to identify methods for monitoring that quality. Therefore, the challenge that meat science researchers face today is to develop innovative methods that deliver for the beef industry in terms of quality measurement. Various initiatives have attempted to solve this problem in several countries worldwide and were discussed in this presentation.

Recently, the demand for on-line or rapid prediction methods of beef quality has significantly increased. The ability to guarantee quality to retailers and subsequent consumers has huge financial implications for the beef industry. This paper reviewed a number of innovative technologies and assessed their potential for measuring aspects of beef quality in on-line situations (Farmer and Farrell, 2017).

The third presentation by Rod Polkinghorne was about value based marketing.

As all beef industry revenue derives from the final consumer the value delivered by the beef meals sold determines the true value of any carcass. Maximum industry efficiency and commercial focus will only be achieved when payment and specification at all points of the supply chain from farm to fork directly relate to this ultimate consumer value. Unfortunately, this is currently not the case resulting in a disconnect between retail description and product performance, as shown in France (Normand *et al.*, 2014) and further disconnection of consumer value, description and pricing at factory and farm level.

Carcass value is a combination of saleable cut weight (yield) and the eating quality performance of each individual portion plus return from co-products such as the hide (Polkinghorne and Thompson, 2010). The EUROP

classification system describes only yield, with moderate accuracy at best, and has no consumer relevance. Other global systems such as USDA and JMGA describe a mix of carcass yield and quality, but lack sufficient accuracy in either trait to deliver a reliable consumer meal outcome. The Australian MSA and similar approaches in Poland and New Zealand predict eating quality at the cut level with sufficient accuracy to deliver consumer value but need to be aligned with accurate yield measures to enable transparent and accurate value based trading (reviewed by (Polkinghorne and Thompson, 2010).

The lack of a clear value based price signal at the farm gate is further compounded by pricing based on averaging which conceals large value differences within groups of cattle. With the advent of cut based eating quality systems and the evolution of accurate yield estimation either by direct cut weighing and ID or through evolving yield technologies such as video imaging, DEXA (dual energy X-ray absorptiometry) and CT (computerised tomography) scanning there is an exciting opportunity to fundamentally change the basis of describing and trading livestock, carcasses and retail beef. The range in true value between visually similar cattle within a group is considerable and sufficient to drive rapid and significant change via culling, genetic selection and management if the price paid accurately reflects their individual value.

This has tremendous potential to drive a massive improvement in industry performance, relevance and prosperity.

Lastly, Jerzy Wierzbicki, Rod Polkinghorne, Jean-François Hocquette, Linda Farmer and Declan Troy presented an update of common language for beef.

The UNECE standard for Bovine Meat - Carcasses and Cuts offers internationally agreed specifications written in a

consistent, detailed and accurate manner using anatomical names to identify cutting lines. The standard also defines a product code allowing all relevant information to be combined in a 20-digit string (–UNECE, 2015). This standardization of the trading language is the foundation, which allows the meat industry to adopt modern data transfer methods and streamline the flow of information and product throughout the supply chain.

The UNECE Meat Carcasses and Cuts Classification is being proposed for use by suppliers as an attribute of the GDSN (Global Product Classification system). In this way, suppliers can use the UNECE meat-cut code to globally specify the cut of each product GTIN (global trade item number) in the GDSN (UNECE, 2013).

To facilitate research collaboration and data interchange or pooling it is recommended that a standardised description for bovine eating quality and yield grading inputs and untrained consumer sensory response be included in the UNECE Bovine language. It is also recommended to engage with ICAR (International Committee for Animal Recording) and ATOL, OntoBeef to ensure optimal linkage of live animal and genomic data (UNECE, 2016). Semantic representation of UNECE Bovine language and their joining into a network of Web vocabulary such as Schema.org and GS1 vocabulary is needed (Trypuz *et al.*, 2016).

An international working group is currently being formed to progress the UNECE agreement and will manage a collaborative project to establish a standard cloud based data structure and associated software tools to assist with trial design, product collection and management and consumer testing. This will facilitate standardised collection of data and pooling where desired.

SESSION 3: BEEF, ENVIRONMENT AND WELFARE

This session comprised also four talks. The first one by Dr Tim Searchinger (Princeton's Woodrow Wilson School of Public and International Affairs) was about beef, land use, climate change and food security.

Demand for global beef and dairy production is on a course to rise 80-90% between 2008 and 2050. Ruminant production generates roughly half of global greenhouse gas emissions from agriculture, and its expansion is responsible for more than half of all clearing of forests and woody savannas. Virtually all scenarios for meeting food needs by 2050 require moderation in the growth of beef demand below these projected levels, and large global increases in the land use and feed efficiency of beef production (Ranganathan *et al.*, 2016). Europe is already a global leader in the greenhouse gas--efficiency of beef production, both because of efficient production systems and the fact that much of the beef production is a co-product of dairy production. European producers can best contribute to a climate-smart future by advancing innovative technologies including more feed-efficient breeds, feed additives that suppress enteric methane, breeding grasses with nitrification inhibition, and advances in manure management.

The second talk by Dr Dequan Zhang (Chinese Academy of Agricultural Sciences, China) was entitled "Making the most of beef co-products".

The loss from animal products is about 5-10%, therefore comprehensive utilization of co-products is required. Animal bone could be a good resource of ingredient for spice and functional food as the content of protein in it is high and it is rich in fat and mineral polysaccharide (chondroitin sulfate). Animal blood is one of the major slaughter co-products and it was estimated that approximately 3 million tons of animal blood is produced yearly in China. Approximately 60 thousand tons of tail fat is produced each year in China. The presentation focused on comprehensive utilization of beef co-products, especially bone, blood and fat, to transfer waste into high value products. Technology and equipment have been developed for bone pretreatment and extraction, separation and concentration and processing. The bone products include bone protein, chondroitin sulfate tablets and bone oil. High-value processing of animal blood technology, equipment and new products have been developed. Some new products, including blood tofu, low ash plasma protein powder, hemoglobin colorant, and plasma protein anti-oxidative peptides have been developed. Some work has been done on high-value processing of animal fat co-products. Oil extraction and separation and high value processing technology have been developed including refining technology of animal fat such as sheep tail tallow. The trend of beef co-products usage in China is to produce

industrialized, edible food, animal feed and organic fertilizer products.

In the third presentation, Prof. Ettore Capri (Catholic University of the Sacred Heart, Piacenza, Italy) described an Italian sustainable platform for beef.

Meat is a food of primary importance. However, for the last two decades, it has been subjected to numerous attacks and criticisms. Among the main accusations relate to its environmental impact and the supposed health problems connected with it.

Various kinds of organisations and stakeholders have participated in the debate on the production and consumption of meat, each characterised by different purposes: animal welfare organisations and/or environmental groups, research centres, media. In this context, the point of view of meat producers in Italy has never been included. For this reason they have felt the necessity to join in the debate by providing information, details and objective data useful to correct opinions which they perceive to be sometimes prejudiced if not completely incorrect.

To achieve this scope, a group of operators in the livestock sector (companies and associations) was organised to support scientific studies that, in a logic of pre-competitive transparency, would be published as a scientific study, “The sustainability of meat and cured meats in Italy”, as well as the launching of the Sustainable Meat Project and of the Web portals www.carnisostenibili.it and www.thesustainablemeat.com.

Born from the common purpose of the three main Italian meat industry associations, Assocarni, Assica and Unaitalia, the Sustainable Meat Project aims to cover all topics related to the world of meat: an unprecedented project in Italy, contributing with an instructing and informative approach to a balanced report on health, nutrition and sustainability.

The Sustainable Meat Project wants to identify the key issues, the state of knowledge and the latest trends in scientific and technical guidelines, showing that production and consumption of meat can be sustainable, both for health and for the environment. The aim is to represent a starting point for a constructive and transparent discussion, free from preconceptions and determined by the desire for scientific and objective analysis.

The main focus of “The sustainability of meat and cured meats in Italy” report is represented by the Environmental Hourglass, which graphically describes the environmental impact of food consumption per week. The study offers the opportunity of a wider reflection on the livestock production chain models in Italy, that generate a turnover of 30 billion Euro per year, compared with about 180 billion Euro of the entire food sector and the 1,500 billion Euro of Italian GDP.

The study analyses in depth the strengths and progress at the base of the Italian meat production model - beef, pork and poultry - increasingly oriented towards issues of sustainability - primarily nutritional and environmental - through the

application of modern technologies throughout the supply chain and the increased sensitivity of the operators in meeting the requirements of a more demanding consumer.

Elaborated from the weekly consumption recommended by nutritional guidelines, multiplied by the average environmental impacts of the different food categories, the Environmental Hourglass is an expression of a broader approach to the vision of diet sustainability, which aims to assess the real environmental impact of the food that is consumed: if consumers follow proper dietary patterns, such as those typical of the Italian Mediterranean diet, the average weekly impact of meat is aligned with that of other foods, for which the unitary impacts are minor, but the quantities consumed are significantly more. The Environmental Hourglass method, which presents a reinterpretation of the food pyramid, surpasses the assessment of the environmental impact in absolute terms (CO₂ emissions per kg of meat compared to a kg produced of other ingredients) and encourages a new approach that focuses the attention on recommended intakes as part of a proper and balanced diet.

In these first two years of operation, the Sustainable Meat Project has achieved excellent results in terms of visibility and communication, becoming a scientific reference point on issues related to the sustainability of meat production and consumption.

The last talk by Dr. Paolo Ferrari (Research Centre for Animal Production, Reggio Emilia, Italy) was about enhancing the welfare of cattle.

RIBECA is an innovative system to assess animal welfare in beef cattle farms.

It has been developed within a two-year project funded by the Italian Ministry of Agriculture and coordinated by the Research Centre for Animal Production CRPA. Its main goal is to assess to the welfare of beef cattle on farm in compliance with relevant EU regulations and EFSA guidelines, to identify critical points and to propose corrective actions.

The project started in September 2013 by testing the system through the involvement of seven beef cattle farms and their associations Asprocarni and Unicarve in the Piedmont and Veneto Regions; at the end of the project 137 farms were assessed according to RIBECA.

Data collected from each individual farm were entered into a database and processed to provide a farm assessment index which has been used to rank each farm in one of the six welfare classes envisaged by the system and to list possible critical aspects and actions to be taken to improve animal welfare.

The outcomes of the assessment suggest that Italian beef cattle farms may have some problems in relation to stall areas particularly (i.e. space allowance, flooring).

Once the survey was completed, CRPA organised events and seminars addressed to farmers, farmer associations, technicians, consultants and veterinarians to disseminate how RIBECA and the relevant animal welfare indicators work.

SESSION 4: ADDING VALUE THROUGHOUT THE SUPPLY CHAIN

This session of four presentations started with a talk by Jonathan Birnie (Dunbia, Dungannon, Northern Ireland) entitled “Supply chain innovations for better beef”.

The European beef chain produces a highly variable product. According to the AHDB (Agriculture and Horticulture Development Board, UK), more than ¾ of UK

consumers have experienced a poor quality beef eating experience, and this variability in quality undoubtedly influences consumer choice and purchasing.

The wide range of quality is a result of wide variation in production and processing standards, which itself is a result of the lack of data recording at farm levels and the inability to

measure quality at abattoir level and feed this back to farm, either as information or in the form of a financial incentive.

The key to addressing variability in the beef chain is in isolating each of the causal factors and applying innovation to each area. In some cases, this innovation will simply mean utilising existing technology in a new way, whereas a lack of knowledge in other areas may require detailed investigation into potential solutions.

The primary causes of variation in eating quality are found at both farm level and in-factory. On-farm, the key causes are the large amount of different genetics, management systems, health policies and diets offered, which ultimately affect the speed at which an animal grows and its overall eating quality. In factory, the key influencing factors include electrical stimulation, chill regime and the length and type of maturation.

At farm level, the most significant need is for technology which simply and inexpensively enables recording of animal performance. This would dramatically increase the number of farmers who could measure the effect of management changes they make on farm and would strongly encourage the uptake of new technology and knowledge to improve performance.

At a factory level, methods of measuring quality at line speed are perhaps the most important requirement, followed by the implementation of methods of incentivising farmers to produce suitable livestock. In addition, the development of effective on-line methods of tenderisation (whether mechanical or natural) would enable more effective marketing of meat.

The second talk by Valeria Viganò (Sealed Air Packaging) was about packaging developments for the meat industry.

A brief presentation of Sealed Air company was followed by an overview of the main aspects in the meat market related to packaging and hygiene solutions. It focused on consumer concerns: from food waste reduction to food safety.

An overview of the global meat market consumption and highlights of the possible causes of the European situation was presented, together with current packaging solutions and future trends.

Then, Drs Ciara K McDonnell and Paul Allen (Teagasc Food Research Centre, Ireland) described new methods for adding value to beef.

SESSION 5: OUTCOMES FROM WORKSHOPS

Delegates were invited to participate in two workshops during the meeting, by engaging in informal discussion during the break period, and by adding their comments using sticky notepaper on to posters provided. The notes were colour-coded to identify scientist and industry contributions and the results were presented by Terence Hagan and David Farrell, respectively.

Workshop 1 asked “How can the industry help to ensure that beef has a positive nutritional impact?” The responses highlighted several key areas, with both industry and scientists raising the same points. The largest number of responses related to the communication to the consumer about the nutritional benefits of beef, with clear, robust messages in an accessible form, e.g. based on portions rather than weight. There was interest in further research on the enhancement of

Recent advances in meat science have led to new knowledge about the application of novel non-thermal processing technologies such as high-pressure processing (HPP), ultrasound (US), pulsed electric fields (PEF) (McDonnell et al, 2014 a, b) and muscle stretching pre- and post-rigor (Hildrum et al., 2002). These technologies could have new potential applications at different points along the meat processing chain to add value. For example, PEF and US are known to cause cellular disruption through electroporation and cavitation, respectively. This could accelerate and increase the extraction yield of valuable proteins from low, neutral or negative meat processing streams. Likewise, these mechanisms could lead to accelerated ageing and increased tenderisation of meat cuts. PiVac is a muscle stretching technique for hot-boned meat which has shown potential for accelerated chilling and improved consistency in tenderness. Further, along the processing chain, US and HPP have shown potential for accelerated salting and a reduced requirement for additives, respectively, in processed meats. Therefore, potential exists for these technologies to add value to beef at different points along the processing chain.

Finally, Dr Phil Hadley (AHDB Beef and Lamb, UK) discussed how to put research into practice.

The UK beef sector has worked hard to raise the quality bar to improve consistency and consumer satisfaction of what is seen as a high cost/quality product. Dissatisfaction often results in a cessation of further purchase for a period of around 12 weeks and potential negative effects on the retailer and their supply chains. The processing sector has paid particular attention to their slaughter and maturation techniques, to include electrical stimulation, suspension method, cut preparation and, most notably, packaging with a move to vacuum and skin pack for most retail beef cuts. AHDB small scale retail purchase surveys have demonstrated the positive impact of these measures by measuring shear force of both beef roasting joints and loin steaks over the recent years and both average tenderness and variability have been reduced, with likely positive impact on consumer satisfaction. The industry continues to strive to produce high quality products with little variability to meet consumer expectations.

the nutritional quality of beef, whether through omega-3 fatty acids or other components such as antioxidants. It was felt that more information and clearer guidelines were needed on the role of beef in a healthy diet: how much is recommended and what is the impact of other meal components. The importance of ensuring that any nutritional changes do not adversely affect consumer eating quality was highlighted. The need for a concerted approach throughout the supply chain and between scientists and industry was emphasised.

Workshop 2 posed the question, “How should the industry manage the environmental impact of beef?” The first issue, highlighted by both scientists and industry, is the need to address the large differences in sustainability between different beef production schemes and respondents suggested that communication and an incentive scheme is needed to

encourage farmers to adopt environmentally friendly systems. Research is needed to optimise diets. The second topic was the need to make the most of all beef products and co-products, aiming for “100% utilisation”. Again, a concerted approach to these issues was suggested.

Lastly, Linda Farmer (Agri-Food and Biosciences Institute, UK) presented an introduction to Beef2Compete, a Thematic Network for the Beef Industry. As outlined in the Introduction, the beef industry in Europe is facing a number of serious challenges, several of which have been discussed in this conference. These include its environmental impact, nutritional value, safety and authenticity and its consistency of eating quality. All of these challenges have an adverse impact on the entire supply chain but especially the farmer, and beef production at the farm level is often of marginal

CONCLUDING REMARKS

Declan Troy (Teagasc, Ireland) concluded by commending the meeting for offering a unique forum for the beef industry to discuss a diversity of interests. He highlighted five messages:

(1) The beef industry needs to be proactive in terms of the nutritional benefits of beef, such as protein, fatty acids, micronutrients and care needs to be taken regarding the communication of the apparent link between cancer and red meat.

(2) Sustainability is and will continue to be an important issue, including environmental, ethical and welfare aspects and the use of co-products. Europe could learn from some of the developments in China we have heard about in this meeting.

profitability. However, a considerable amount of research has been conducted and some beef production systems have addressed these issues. Beef2Compete aims to gather together best practice from both industry and scientific sources across Europe to help farmers to address these challenges.

A consortium of 13 organisations from nine countries comprising both industry representative bodies and scientific organisations are bidding for funding from the EU for a “Thematic Network” for the beef industry. This bid was submitted on 14 February and it is hoped that we will hear a positive result in June! If successful, Beef2Compete will provide funding for beef producer and industry representatives together to identify the best practices and scientific innovations that will help the European beef industry address its challenges.

(3) Quality systems need to focus on the consumer experience, whether they relate to genomics, processing, packaging or other factors. The need to be able to integrate the “big data” from production and processing will be important.

(4) Technology and knowledge transfer continues to be very important. There is a research pipeline from universities and pure research to more applied research and its application. The “valley of death” for translational research needs to be addressed.

(5) All of these initiatives need to lead to improvements across the supply chain in terms of measuring, monitoring and managing beef production to deliver a sustainable, healthy and high quality product.

References:

- Bastide N. M., Pierre F. H. F. Corpet D. E. (2011). Heme iron from meat and risk of colorectal cancer: A meta-analysis and a review of the mechanisms involved. *Cancer Prevention Research*, 4, 177–184.
- Bonny S.P.F., Gardner G.E., Pethick D.W. Legrand I., Wierzbicki J., Allen P., Farmer L.J., Polkinghorne R.J., Hocquette J-F. (2017). Untrained consumer assessment of the eating quality of European beef: 2. Demographic factors have only minor effects on consumer scores and willingness to pay. *Animal*, in press.
- Bonny S.P.F., Hocquette J.F, Pethick D.W., Farmer L.J., Legrand I., Wierzbicki J., Allen P., Polkinghorne R.J., Gardner G.E. (2016b). The variation in the eating quality of beef from different sexes and breed classes cannot be completely explained by carcass measurements. *Animal*, 10:6, 987–995.
- Bonny S.P.F., Pethick D.W., Legrand I., Wierzbicki J., Allen P., Farmer L.J., Polkinghorne R.J. Hocquette J.F, Gardner G.E. (2016a). European conformation and fat scores have no relationship with eating quality. *Animal* 10, 996–1006.
- Bonny S.P.F., Pethick D.W., Legrand I., Wierzbicki J., Allen P., Farmer L.J., Polkinghorne R.J. Hocquette J.F and Gardner G.E. (2016c). The maturity estimate most accurate in predicting eating quality depends on the age range of the cattle examined. *Animal*, 10(4), 718–728.
- Bouvard V., Loomis D., Guyton K. Z., Grosse Y., Ghisssassi F. E., Benbrahim-Tallaa L., Guha N., Mattock H., Straif, K. (2015). International agency for research on cancer monograph working group. Carcinogenicity of consumption of red and processed meat. *Lancet Oncology*, 16, 1599–1600.
- Bovine Meat Carcass and Cuts - Edition 2015. UNECE - Standards and recommendations. [Online] 2016. https://www.unece.org/fileadmin/DAM/trade/agr/standard/meat/e/Bovine_326Rev2E_2016.pdf.
- Codification system - Edition 2013. UNECE - Standards and recommendations. [Online] 2013. http://www.unece.org/fileadmin/DAM/trade/agr/standard/meat/Codification_system_eng.docx.
- Demeyer, D., Mertens, B., De Smet, S., Ulens, M. (2016). Mechanisms linking colorectal cancer to the consumption of (processed) red meat: a review. *Critical Reviews in Food Science and Nutrition*, 56, 2747-2766.
- De Smet S., Vossen E. (2016). Meat: The balance between nutrition and health. A review. *Meat Science*, 120, 145–156.
- Eating quality – proposals by the discussion group. UNECE – Twenty-Fifth session of the specialized section on standardization of meat (GE.11). [Online] June 7, 2016. http://www.unece.org/fileadmin/DAM/trade/agr/meetings/ge.11/2016/ECE_CTCS_WP.7_GE.11_2016_08E.pdf.

- Farmer L., Bowe R., Troy D., Bonny S., Birnie J., Dell'Orto V., Polkinghorne R., Wierzbicki J., De Roest K., Scollan N.D., Henchion M., Morrison S., Legrand I., Roehe R., Hocquette J.-F., Duhem K. (2016). Report of the workshop “Sustainable beef quality for Europe – A workshop for industry and scientists”. *Viandes et Produits Carnés*, VPC-2016-32-1-6.
- Farmer, L.J. and Farrell, D.T. (2017). Beef Eating Quality - A European Journey. *Animal*, in press.
- Hildrum, K.I., Nilsen, B. N, Wahlgren M. (2002). Improving the tenderness of hot boned beef muscles-Restriction methods of rigor mortis contraction can reduce the effects of cold shortening. *Fleischwirtschaft* 82, 114-121
- Moreno, T., Keane, M.G., Noci, F, Moloney, A.P. (2008) Fatty acid composition of M. Longissimus dorsi from Holstein–Friesian steers of New Zealand and European/American descent and from Belgian Blue x Holstein–Friesian steers, slaughtered at two weights/ages. *Meat Science* 78, 157–169.
- McDonnell, C.K., Lyng, J.G., Arimi, J.M., Allen, P. (2014a). The acceleration of pork curing by power ultrasound: A pilot-scale production. *Innovative Food Science & Emerging Technologies* , 26, 191-198.
- McDonnell, C.K., Allen, P. Chardonnerau, F.S., Arimi, J.M., Lyng, J.G., (2014b). The use of pulsed electric fields for accelerating the salting of pork. *LWT-Food Science And Technology*. 59, 1054-1060.
- Normand J., Rubat E., Evrat-Georgel C., Turin F., Denoyelle C., 2014. Les français sont-ils satisfaits de la tendreté de la viande bovine ? [A national survey of beef tenderness in France]. *Viandes et Produits Carnés*, VPC-2014-30-5-2. http://www.viandesetproduitscarnes.fr/phocadownload/vpc_vol_30/3052_normand_enquete_nationale_tendrete.pdf.
- Polkinghorne R.J. and Thompson J.M. (2010). Meat standards and grading - a world view. *Meat Science* 86, 227-235.
- Prieto N., Ross D., Navajas E., Richardson R., Hyslop J., Simm G., Roehe R. (2011). Online Prediction of Fatty Acid Profiles in Crossbred Limousin and Aberdeen Angus Beef Cattle Using Near Infrared Reflectance Spectroscopy. *Animal*, 5, 155-165.
- Ranganathan, J., Vennard, D., Wate, R., Lipinski, B., Searchinger, T., Dumas, P., Forslund, A., Guyomard, H., Manceron, S., Marajo-Petitzon, E., Le Mouël, C., Havlik, P., Herrero, M., Zhang, X., Wirsenius, S., Ramos, F., Yan, X., Phillips, M. and Mungkung, R. (2016). Shifting Diets for a Sustainable Food Future. Working Paper, Installment 11 of Creating a Sustainable Food Future. Washington, DC: World Resources Institute. Accessible at <http://www.worldresourcesreport.org>.
- Roehe R., Dewhurst R.J., Duthie C.-A., Rooke J.A., McKain N., Ross D.W., Hyslop J.J., Waterhouse A., Freeman T.C., Watson M., Wallace R.J. (2016). Bovine host genetic variation influences rumen microbial methane production with best selection criterion for low methane emitting and efficiently feed converting hosts based on metagenomic gene abundance. *PLoS Genet* 12(2): e1005846. doi:10.1371/journal.pgen.1005846.
- Scollan N.D., Dannenberger D., Nuernberg K., Richardson I., MacKintosh S., Hocquette J.F., Moloney A.P. (2014). Enhancing the nutritional and health value of beef lipids and their relationship with meat quality. *Meat Science*, 97, 384-394.
- Polkinghorne R.J., Thompson J.M. (2010). Meat standards and grading: a world view. *Meat Science* 86, 227–235.
- Trypuz R., Kulicki P., Grądzki P., Trójezak R., Wierzbicki J. (2016). Conference: 10th Metadata and Semantics Research Conference, At Göttingen, Germany. Conference Paper: Machine-understandable and processable representation of UNECE standards for meat. Bovine Meat - Carcasses and Cuts case study. [Online] 2016. https://www.researchgate.net/publication/305619557_Machine-understandable_and_processable_representation_of_UNECE_standards_for_meat_Bovine_Meat_-_Carcasses_and_Cuts_case_study.