Final Report Summary - WELFARE INDICATORS (Development, integration and dissemination of animal-based welfare indicators, including pain, in commercially important husbandry species, with special emphasis on small ruminants, equidae & turkeys)

Executive Summary:
The European Animal Welfare Indicators Project (AWIN) addressed the development, integration and dissemination of animal-based welfare indicators with emphasis on pain assessment and pain recognition. AWIN research objectives were carried out in four complementary workpackages (WP1, WP2, WP3 and WP4). The project focused on five commercially important species: sheep, goats, horses, donkeys and turkeys. All workpackages carried out research and dissemination with two or more of the key species with some outputs relevant to all animals.

WP1 developed practical, science-based, welfare assessment protocols, including pain indicators, for the project species. WP1 developed a two-step approach to animal welfare assessment and this process is carried through the resulting protocols which are all freely available online. AWIN translated the welfare assessment protocols into interactive apps to make data collection easy, reliable and available immediately as a management tool to help with decisions at farm level, promoting mechanisms for data storage and data-analysis. The ‘I-Watch-Turkey’ app, based on an AWIN-developed ‘transect’ methodology, was tested on turkey farms in Europe, North America and Brazil. WP1 contributed to an EFSA Scientific Opinion on Sheep Welfare and on a European Commission Report on Equine Welfare.

WP2 studied the impact of diseases and pain on animal welfare and, in conjunction with WP4, developed interactive apps to facilitate data collection, data storage and data analysis. In goats and sheep the focus was on pain assessment and mitigation in animals with mastitis, pregnancy toxaemia and foot-rot. Conditions which caused lameness in goats were also studied. The ‘WelGoat’ app, to assess lameness was developed, by WP2 and WP4. Strategies to measure and control pain during lamb castration and tail-docking and goat disbudding were investigated. In horses, studies were carried out to mitigate pain post-castration and during laminitis. Partners also provided a report on the barriers to the implementation of pain mitigation protocols. WP2, WP1 and WP4 worked together to develop the ‘Horse Grimace Scale’ app was developed, which accounted for more than 5,000 downloads from the Google Play Store.

WP3 examined the effects of different prenatal environments, studying animal density, group size and the quality of human and animal interactions in pregnant sheep and goats. Welfare indicators and developmental outcomes were assessed in the offspring of the studied animals. WP3 found that stocking density affected pregnant ewe and pregnant goat behaviour and pregnant ewe physiology. Stocking density of pregnant animals also affected the foetuses, behaviour of the offspring, maternal behaviour and placental morphology. Prenatal management strategies were studied in mares and their foals. Group dynamics in group-housed horses affected pregnancy and mares’ physiological measures of stress.

WP4 created the Animal Welfare Science Hub (www.animalwelfarehub.com) to disseminate our scientific findings, promoting transparency and synergies among stakeholders and interested parties. The Hub is a global research and education repository for up-to-date scientific knowledge in animal welfare. Outcomes from the AWIN project were disseminated via the Hub through
the use of interactive learning objects (LOs) and stakeholder engagement activities. This is the first organized initiative to combine animal welfare science with innovative media and synergic networking. LOs were produced covering the AWIN project activities, including pain assessment, prenatal environment, welfare indicators and assessment protocols, among many others. The Animal Welfare Science Hub is the largest peer-reviewed portal in animal welfare science in the world. Interactions with stakeholders and interested parties were very effective. AWIN delivered talks to more than 30,000 participants and was present in events with audiences exceeding 253,000 people. More than 29 peer-reviewed articles have been published so far and an equal number have been recently submitted for publication.

The Animal Welfare Indicators Partners decided to remain together as a network of excellence, focusing on the development and validation of science based welfare indicators and also on the strategy to provide outstanding opportunities to foster effective communication among stakeholders and interested parties, through the Animal Welfare Science Hub.

Project Context and Objectives:
1.1 Background and context
Animal welfare is one of the main topics in modern animal agriculture that has been consistently ranked at the top of issues raised by consumers and politicians across European countries and in other parts of the world. In addition, Europeans are concerned with the need to meet animal welfare standards in countries supplying the European markets with animal products. There is also growing evidence that consumers view animal welfare to be closely associated with food safety and quality. The focus of scrutiny on animal welfare issues puts pressure on lawmakers who are expected to offer rapid and effective solutions to perceived animal welfare problems. Animal welfare legislation has sometimes developed with suboptimal access to scientific information, an issue that has compromised the ability to truly safeguard animal welfare and leads to considerable uncertainty in the animal industry. In the absence of science-based information, legislation may develop in ways that are not conducive to the long-term sustainability of farming. One goal of the AWIN project is to develop a framework to facilitate the implementation of science-based legislation on animal welfare. In order to accomplish that, the 11 partner institutions considered a combination of applied and fundamental questions that are of importance to facilitate promotion of sustainable livestock production. A major outcome of this project will be to encourage long-term competitiveness in the European animal industry through a transparent and inclusive relationship with other stakeholders and interested parties such as legislators and consumers.

The AWIN Project was developed in the context of the European 7th Framework for Research and Innovation. The project followed the successful Welfare Quality® Project, funded under the European 6th Framework for Research and Innovation. The timing of the project coincided with that of the European Union Strategy for Protection and Welfare of Animals, 2012-2015, and part of the activities ran in parallel with the pilot initiative to study the viability of establishing the European Network of Reference Centres for the protection and welfare of animals, in the EUWelNet. The planned network of reference centres should ensure that the competent authorities receive coherent and uniform technical information on the ways to implement EU legislation, especially in the context of outcome-based animal welfare indicators. Motivated by the current status of animal welfare science, The European Food Safety Authority, EFSA, included animal-based welfare-outcome indicators of welfare in their scientific opinions. Globally, the World Veterinary Association adopted, during the 2011 Annual Conference in South Africa, a clear agenda to become more important actors in the area of animal welfare, a landmark for the profession. The European Commission DG SANTÉ Office, working together with the United Nations Food and Agriculture Organisation, hosted meetings in Brussels and in Washington in 2012, to discuss in detail, with stakeholders and interested parties, the European Union Strategy for Protection and Welfare of Animals 2012-2015. In 2012, the European Commission had the innovative idea to merge animal health and animal welfare sponsoring the Animal Health and Welfare ERA Net, which followed the successful EMIDA programme. Across the world, new teaching, research and extension positions were established to address animal welfare. Support for the demands in teaching resources was very limited. The Norgesuniversitetet sponsored the very first animal welfare digital library, which was hosted by the Norwegian University of Life Sciences. It was developed in the background of a growing engagement of the World Organisation for Animal Health (OIE), with its member countries to establish global animal welfare standards. The context was also influenced by the mixed responses of stakeholders and interested parties to the validated protocols published by the Welfare Quality Project®, which were considered demanding in terms of time investment to complete the assessment. The recent advances in automated systems to monitor and manage
animals, combined with the presence of digital resources and information technology capabilities on farms, prompted the focus on the development of apps.

The researchers involved in the AWIN project considered also the need to further knowledge in other areas of animal welfare research. There had been few studies on the impact of diseases on animal welfare. In addition, protocols to assess pain have often been subjective and lacking specificity to address problems in the species that the AWIN partners were asked to investigate. The potential for pain is widespread amongst animals in production systems partly as a consequence of the management procedures that are sometimes required to prevent other major health consequences. In addition, it arises as a result of unintentional, incorrect management practices or because of certain diseases. Therefore pain can result in welfare that is poor and unacceptable. Behavioural and physiological indicators of both short- and long-term pain and discomfort associated with the physical or social environment of the animals are basic measures of welfare that still needed to be more systematically addressed under commercial conditions. The prenatal environment and the early neonatal environment in domestic farm animals are affected by management decisions and this could have either positive or negative impact on welfare and health outcomes, on the mother and offspring. The prenatal and early postnatal environment, which was studied in this project, can offer opportunities to enhance the organisation of coping systems in the brain, and may serve as a useful model to address consequences of positive and negative experiences early in life as well as studying animal welfare measures in a more systematic way. By testing stimuli or environmental conditions (e.g. group size or animal density) that have a major impact under commercial conditions, the measures tested in such a model may be of direct relevance to on-farm welfare assessment methods. In most production systems, an increasing number of animals are loose-housed and kept in social groups. Group size, animal densities and human handling are all major factors affecting their welfare. It is highly unlikely that “fixed” measures and pre-determined protocols could be widely applied across different animal species, breeds, management strategies and environmental conditions. It is our understanding that the validity of welfare indicators is greatly affected by genetic and epigenetic factors.

The dominating feature in the 21st century in most areas of human activities is the excess of available information, which often lacks proper scrutiny regarding scientific validity. Stakeholders and interested parties, in animal welfare, operate in an environment with conflicting interests, and limited opportunities for common approaches to be guided by sound science. The Animal Welfare Science Hub (www.animalwelfarehub.com) was developed to fill the gap in dissemination strategies, to point to valid educational opportunities and also to foster effective communication among stakeholders and interested parties. Our goal is therefore to develop animal welfare indicators that offer support to help existing legislation and facilitate future legislation. We decided to set up protocols that will promote integrated approaches among stakeholders that will identify optimal ways to improve animal welfare, while ensuring the sustainability of animal production in the 21st century. Moreover, with the prospect of unprecedented challenges in negotiating items related to climate change across the globe, we suggest that an optimal framework to address items with societal impact such as animal welfare will be extremely valuable.

1.2 Objectives and actions

The multidisciplinary team in workpackage 1 (WP1), a) developed and b) refined existing strategies and models for welfare, including quantifying pain and developing assessment protocols, with special emphasis on goats, sheep, equines and turkeys. This part of the project a) developed new and b) refined already-documented on-farm welfare protocols that focus on individual-based measures, and also c) included an evaluation of how these relate to crucial environmental conditions such as flooring, group size, animal densities and the human-animal relationship. Just as behavioural responses will always depend on the present environmental conditions, animal welfare indicators have to take account of the environment. The validated indicators and the combined protocols were translated into apps to facilitate data acquisition, processing, visualization and data storage.

In workpackage 2 (WP2), the relationship between animal welfare and diseases was studied with a focus on behavioural and physiological indicators of pain and discomfort. Novel pain assessment methodology was developed, in particular the
assessment of facial expressions in equine and small ruminants. A dedicated biomarkers laboratory was deemed necessary to study the usefulness of cytokines and glucocorticoids in pain evaluation. Areas addressed include: a) an assessment of attitudes of stakeholders towards pain and diseases in goats, sheep, equines and turkeys; b) the welfare consequences of foot-rot and other causes of lameness in small ruminants; c) the welfare consequences of laminitis in horses; d) the welfare consequences of mastitis and pregnancy toxæmia in small ruminants; e) the evaluation of pain and pain management protocols and on-farm management procedures in small ruminants. Results from this research helped to inform the protocols developed by WP1.

In workpackage 3 (WP3), real scenarios in relation to the social and physical environment during prenatal and early postnatal periods were studied so as to assess impact on developmental processes likely to contribute to individual variability in indicators of animal welfare, as measured in adult animals. WP3 investigated prenatal consequences of the social environment, as well as human handling, on indicators of animal welfare. In small ruminants, there was focus on: a) animal densities, b) group size and c) positive vs. negative handling. In horses, the focus was on social groups vs. social isolation during crucial periods in pregnancy as well as previous social experience or no social experience. In addition, the impact of the quality of human-animal interactions was assessed. Furthermore, findings showing that even mild or moderate stressors can change the behavioural styles of offspring even into adulthood, underlines the importance of understanding how we can produce robust and well-adapted breeding animals. Again, the results from WP3 were used to inform the protocols developed by WP1.

The three ‘research’ workpackages form a good example of how applied and more basic science approaches work hand in hand to produce a solid scientific platform to benefit animal welfare.

In workpackage 4 (WP4), the objectives were: a) to facilitate the dissemination of the science produced in the project in an effective way, b) to build competence in animal welfare science through the development of the animal welfare science hub, hosting a database on available teaching research and extension resources, c) to provide access to peer reviewed science-based information on animal welfare, d) to train scientists to use novel digital and information technology resources to communicate with stakeholders and interested parties, e) to develop learning objects (LOs) to integrate applied and fundamental aspects in animal welfare research. WP4 helped to create a long-lasting relationship with stakeholders and interested parties.

The focus of each of the workpackages in this project were to enable animal welfare legislators and policy makers to develop science-informed legislation and policies including the requirement to implement animal-based welfare assessments in the practical farming of various commercially exploited species.

Project Results:
AWIN WP1 aimed to develop and refine welfare assessment protocols using animal-based indicators, including pain, in sheep, goats, horses, donkeys and turkeys. The welfare assessment protocols developed by the AWIN project are grounded on the four welfare principles and twelve criteria developed by Welfare Quality® and are complete but not complex, so that their application can meet current needs. Stakeholders’ opinion and farmers’ experience were crucial for the successful implementation of the protocols.

AWIN protocols are designed to enable comparisons among similar production and management systems and are intended to provide validated indicators to assess animal welfare in order to guide its improvement throughout Europe and elsewhere in the world. A two level approach, with the exception of turkey welfare assessment, protocol, is adopted for animal welfare assessment at farm level to increase feasibility and acceptability without losing scientific validity. The protocols offer, as a first level, a quick screening, consisting of a selection of robust and feasible animal-based indicators, which can be readily applied and require no, or minimal handling of animals. Depending on the outcome of the first level assessment, a second level, consisting of more comprehensive and in depth assessment, may be recommended. In the second level protocols, animals are often handled, but the welfare assessment is still feasible and can be conducted in a time that is possible during an inspection.
The protocols are intended to give a clear and immediate visual feedback to the farmers about the welfare of the animals on the farm, highlighting positive conditions and enabling comparison with a reference population. The protocols can be seen and discussed at the Animal Welfare Hub and are available on a pen drive. This report discusses the AWIN approach to on-farm welfare assessment from the selection of animal based indicators to computer based welfare data collection systems.

Animal welfare assessment is one of the pillars of productive, efficient and sustainable production systems. Since the beginning of the 21st century, on-farm welfare monitoring systems have been developed. Initially monitoring schemes were largely based on environmental assessments, such as design or resource indicators, which assess inputs that could affect animal welfare. These resource-based and management-based measures should be considered as risk factors that might affect welfare; however in order to assess animal welfare at farm level, it is crucial to develop and use animal-based measures. These indicators provide a more accurate welfare assessment as they give direct information about the response of, and the effects on, the animal. Animal-based measures are considered by EFSA to be “the most appropriate indicators of animal welfare and a carefully selected combination of animal-based measures can be used to assess the welfare of a target population in a valid and robust way” (EFSA, 2012). The European Commission emphasizes the use of science-based animal welfare indicators as a possible means to simplify the legal framework and allow flexibility to improve competitiveness of livestock producers (EC, 2012).

The first welfare assessment protocols built on animal-based measures were developed by the Welfare Quality® project, funded within the 6th EU Framework Programme, for pigs, poultry, dairy and beef cattle (Welfare Quality® Protocol, 2009a, Welfare Quality® Protocol, 2009b, Welfare Quality® Protocol, 2009c). This project developed a scheme where the needs of animals are related to four welfare principles and twelve welfare criteria, considered necessary to cover all aspects of animal welfare.

After dealing with welfare assessment of some of the most common farmed species, the 7th Framework Programme of the European Commission specified that there was a need to develop valid welfare assessment protocols in commercially important husbandry species not yet covered in previous projects. The AWIN (Animal Welfare Indicators) project focused on sheep, goats, horses, donkeys and turkeys by developing, integrating and disseminating information about animal welfare indicators. These animal species offer challenges since they have been less studied and thus there is generally less information available on well-validated welfare indicators. In addition, the heterogeneity of the farming systems and environments in which these animals live can make the assessment more difficult.

AWIN also puts special emphasis on the recognition and assessment of pain, as pain is an area that is frequently lacking from many animal welfare assessments and yet is often key when animal welfare problems arise. AWIN WP1 aimed to develop and refine welfare assessment protocols using animal-based indicators, in sheep, goats, turkeys and equines (horse and donkey). These protocols will also include pain evaluation, a key issue not sufficiently addressed so far in the previous protocols. The welfare assessment protocols developed by WP1 are grounded on the four welfare principles and twelve criteria developed by Welfare Quality® and are complete but not complex, so that their application can meet current needs. In other parts of the AWIN project, information about welfare indicators usable for all animals was collected. AWIN puts special emphasis on the recognition and assessment of pain, as pain is an area that is frequently lacking from many animal welfare assessments and yet is often key when animal welfare problems arise.

2.1.1. Identifying promising animal-based indicators
As a starting point, WP1 reviewed background scientific information to select promising animal-based indicators to be included in the protocols. Indicators were classified according to the 4 principles and the 12 criteria developed by Welfare Quality® and assessed for their validity, reliability and feasibility, identifying gaps in current knowledge. From this process, at least one indicator for each welfare criterion was selected to be included in the protocols. AWIN scientists developed a research action plan to address the lack of knowledge regarding the validity, repeatability and feasibility of single promising indicators where this was not present in the literature.
The work involved collaboration with WP2 of the AWIN project, which addressed the relationship between disease, pain and animal welfare and with WP3, which examined the effects of prenatal social environments, social dynamics and prenatal handling methods on the development and welfare of the considered species. New indicators were developed and results were published in peer reviewed journals and transferred into freely available e-learning material (Animal Welfare Science Hub) in collaboration with WP4. Welfare assessment protocols were developed using animal-based indicators, although some resource-based indicators were included when no animal-based indicators were available to assess specific aspects.

2.1.2 Stakeholders’ consultation

To develop the welfare assessment protocols, stakeholders’ perception of the selected indicators was taken into consideration. The purpose of involving the stakeholders was to increase the acceptability of the project outcomes through stimulation of a multidisciplinary dialogue, and identify solutions to potential barriers to the application of the protocols in practice. Stakeholders’ opinion and farmers’ experience were crucial for the successful implementation of the protocols. The research team of AWIN at the University of Milan with the collaboration of CTU - the university eLearning and audiovisual production Center of Milan - developed a questionnaire (http://www.Questionari.unimi.it/awin/) aimed at understanding the current opinion of various stakeholders (farmers, veterinarians, owner, etc.) on the importance of animal welfare indicators for different species (sheep, goats, horses, donkeys and turkeys). This survey, in five languages, has been hosted within websites of different global and national and stakeholders (such as FAO, International Society for Equitation Science, Italian Equestrian Federation, Istituto Zooprofilattico Sperimentale dell’Abruzzo e del Molise “Giuseppe Caporale”). 279 people from different European and non-European countries (e.g. countries from Asia, Australia, North and South America) answered the online survey. The majority of questionnaires referred to horses (40%) and sheep (30%) with the remainder on goats, donkeys and turkeys. According to the different species, different stakeholders answered i.e. owners are the most representative categories for horses, while veterinarians and farmers for sheep and the other species. The listed animal based indicators made by the stakeholders were similar to the ones studied in the current project.

In addition, the welfare assessment prototypes for horses, donkeys, sheep, goats and turkeys were discussed with a network of stakeholders in several meetings, gaining feedback on their acceptability and feasibility, and facilitating the experimental phases of the project through practical support for the on-farm testing of the protocols.

2.1.3 Testing the welfare assessment prototype protocol on-farm

The usefulness of the five prototypes (one for each species) was verified for on-farm feasibility, in order to produce practical, feasible and reliable welfare assessment protocols, including pain measures, for the five species as reported below.

2.1.3.1 Sheep

The AWIN sheep welfare protocol has centred on the breeding ewe population, as the type of animal which constitutes the most abundant group within the flock. The biological requirements of the sheep have been used to develop specific animal-based indicators, which are feasible, valid and reliable. Many sheep farms are extensively managed, and the ability to investigate the welfare of sheep at close quarters and on an individual basis in a feasible manner is severely reduced. The AWIN sheep welfare assessment protocol, therefore, is conducted in two stages. The first level assessment occurs at a flock or group level, and does not require animals to be handled. Only for farms that do not meet the minimum requirements is a second level assessment recommended where individual animals are assessed.

There are nearly 100 million sheep in the EU, kept for meat, milk, wool and their skins. Their production is diverse: spanning intensively housed dairy sheep, free-ranging populations; shepherded flocks that have daily close contact with humans to flocks that only rarely encounter people. The sheep themselves are also diverse: within the UK alone more than 80 sheep breeds and crosses are in commercial production. Reproductive cycles are generally seasonal, so the composition of the flock, and their reproductive status, will vary throughout the year. Against this picture of great diversity, EU consumers wish to be assured that sheep are kept in acceptable conditions, and producers wish to optimise their production, by ensuring that their animals experience good standards of health and welfare. AWIN has addressed these needs by developing a welfare assessment protocol for sheep. With such diversity present, instead of using resource or input based assessments, which will
be impossible to specify, a protocol based on the needs and requirements of the sheep has been designed. The AWIN sheep welfare protocol has centred on the breeding ewe population, as the type of animal which constitutes the most abundant group within the flock. The biological requirements of the sheep have been used to develop specific animal-based indicators, which are feasible, valid and reliable. Many sheep farms are extensively managed, and the ability to investigate the welfare of sheep at close quarters and on an individual basis in a feasible manner is severely reduced. The AWIN sheep welfare assessment protocol, therefore, is conducted in two stages. The first level assessment occurs at a flock or group level, and does not require animals to be handled. Only for farms that do not meet the minimum requirements would a second level assessment be recommended where individual animals are assessed. In the UK, 32 commercial farm visits were conducted to test the protocol on meat sheep farms. Fifteen farms were visited on two occasions: winter (between November and February) and summer (between June and September), and two farms were visited only once (summer visits conducted in August). In Spain 15 commercial flocks were monitored twice: spring (between March-June) and autumn (September-November). The Spanish flocks were selected to test the protocol under a diversity of conditions in terms of productive orientation (dairy vs meat), breed (Latxa, Assaf, Rasa or Secureña), location (5 different Autonomous Communities: Basque Country, Navarra, Aragón, Castilla-León and Andalousia), environmental conditions (humid vs dry areas), reproductive management (1 lambing per year vs 3 lambing in 2 years) and level of intensification (full time indoors vs only temporarily indoors managements).

2.1.3.2 Goats

The prototype for lactating dairy goats in intensive production systems was tested in 60 dairy goat intensive farms (30 in Italy and 30 in Portugal) with different sizes (mean ± s.e. 192.25 ± 29.22; min 14; max 1,147 lactating goats) and characteristics (e.g. presence/absence of feeding rack, stocking density, feeding space, etc.), in order to test the feasibility of the selected indicators in different farming conditions. Twenty farms were visited by two trained assessors at the same time, in order to check inter-observer reliability, whereas 20 farms were visited twice (in winter and in summer) by the same assessor, in order to check intra-observer reliability and consistency across seasons.

2.1.3.3 Turkeys

Welfare assessment protocols must be science based and reliable, but also they must be practical for on-farm application. In this regard, protocols that are simple to implement and easy to understand by farmers and technical staff are more likely to be understood, adopted, and ultimately become a relevant tool for guiding the companies’ decision making process. On-farm welfare assessment in commercial meat poultry is particularly challenging because of the large number of individuals composing the flocks. Current available protocols for meat poultry requires catching and bird handling, resulting in a procedure that is time, manpower demanding, expensive and dangerous for birds and humans in the case of turkey assessment. However, farmers and flock supervisors in turkey production conduct daily routine checks based on walks through the production houses. These screenings allow individuals with visible severe problems to be identified, providing an estimation of the flock health and welfare status with minimal disruption to the birds. The new turkey protocol based on the transect approach method of assessment provides the dynamism of the walk-through inspections, but is conducted in a way that provides veracity, and inter-observer reliability. The transect method for turkey welfare assessment consisted of standardized walks through which the frequency of birds observed showing any of the predefined welfare indicators are collected and results standardized according to the actual population size. Transect walks allowed the detection of small variations in the prevalence of most welfare indicators considered across houses, while showing high inter-observer reliability. The results obtained in the turkey study provide supporting evidence that the transect approach is a simple, but reliable, method of on-farm welfare assessment. The method has the advantage of being readily acceptable and easy to implement by producers, while maintaining high inter-observer reliability, and requiring minimum training.

The ‘I-Watch-Turkey’ app specifically developed for on-farm turkey welfare assessment allows easy assessment of the incidence of the most relevant welfare indicators in a simple manner at the time of regular health inspection. Transect walk prototype for intensive systems for growing turkeys, both males and females, was tested 1 to 2 weeks before slaughter in 46 farms: 18 in Italy, 10 in USA, 8 in Turkey and 10 in Portugal. In each country the assessors were trained in order to reach a uniformity in data collection. The evaluation has been performed both with the appropriate recording sheet and the i-
2.1.3.4 Horses
In a single facility each animal may have a different owner and this poses the question of responsibility and of how the information about welfare should be aggregated and communicated. They face specific challenges related to long distance transport; moreover, equines have a long life expectancy so focus on individual animals is also required. The prototype for single stabled horses over than 5 year old was tested in 40 farms, 20 in Italy, 20 in Germany. All the facilities participated to the study on a voluntary basis. A representative sample of facilities was selected according to their geographical distribution and number of horses present in each facility. A selection of a stratified random sample of very small (n=6), small (n=6), medium (n=18) and large horse facilities (n=10) was performed. The approximate time needed for assessing a horse varies between 5 min (first level welfare assessment) and a maximum of 25 min (second level welfare assessment).

2.1.3.5 Donkeys
The prototype for donkeys over than 1 year old was tested in 20 farms, 12 in Italy, 8 in UK. It assessed a sample of donkey farms representative of the different uses for which donkeys are kept. Committed to reach AWIN goals and, building on recommendations from the expert stakeholders, AWIN researchers developed a strategic plan to work collegially with stakeholders to assess the usefulness of the prototype welfare assessment protocol for donkeys. The Donkey Sanctuary (UK and Italy) collaborated in the selection of farms and facilitating data collection in UK. The approximate time needed for assessing a donkey varies between 5 min (first level welfare assessment) and a maximum of 10 min (second level welfare assessment).

2.1.4 AWIN welfare assessment protocols
The protocols were refined according to the results of WP1 studies and the feedback from the stakeholders favouring the use of indicators with the highest acceptability. The finalised list of indicators was derived based on the feasibility of collection following the on farm testing, the prevalence of the indicator on commercial farms, evidence for its ability to discriminate between farms, and the weighting placed on the indicator by the stakeholder consultation. In addition, at least one indicator was retained in the list to meet each of the 12 Welfare Quality® criteria.

Final welfare assessment protocols for sheep, goats, turkeys, horses and donkeys were produced following on farm testing and stakeholder consultation. AWIN protocols are designed to enable comparisons among similar production and management systems and are intended to provide validated indicators to assess animal welfare in order to guide its improvement throughout Europe and elsewhere in the world. Pdf documents were uploaded into ECAS and the Animal Welfare Science Hub.

2.1.5 Final considerations
A two level approach, with the exception of the turkey welfare assessment protocol, is adopted for animal welfare assessment at farm level to increase feasibility and acceptability without losing scientific validity. The protocols offer, as a first level, a quick screening consisting of a selection of robust and feasible animal-based indicators, which can be readily applied and require no or minimal handling of animals. Depending on the outcome of the first level assessment, a second level, consisting of more comprehensive and in depth assessment, may be recommended. In the second level protocols, animals are often handled, but the welfare assessment is still feasible and can be conducted in a reasonable amount of time. At the end of the first level data collection, a clear and immediate output for the farmers is generated by an excel file or by specific interactive smartphone applications under development at the time of reporting (AWINGoats, AWINHorse). The apps have been developed in order to improve the digitalized data collection system used for prototype testing These apps will facilitate data collection, storage and analysis, and will soon be freely available on Google Play Store and App Store for tablet or smartphone. The output of the protocols aims to give a clear and immediate visual feedback to the farmers about the welfare of the animals on the farm, highlighting positive conditions and enabling comparison with a reference population. Due to differences in production systems, the assessment procedure was different for the turkey welfare assessment protocol. The decision to assess the effectiveness of the transect walks methodology for on-farm application was based primarily on its potential as a valid, effective, and precise method of providing a reliable evaluation of critical welfare issues common in meat poultry. The
simplicity of the methodology means it requires simple training and the cost of the assessment is significantly reduced, while potentially allowing a higher degree of homogeneity in the evaluator assessment. This new approach does not involve turkey manipulation and therefore there is minimal impact on the turkeys and less demand on time constraints and personnel. Apart from the protocol, the turkey research team in WP1 and 2 have also developed an interactive smartphone and tablet app to facilitate data collection, data storage and data analysis, which is freely available at the Google Play Store (i-WatchTurkey).

2.2 The results from workpackage 2 (WP2)

2.2.1 Attitudes towards pain

2.2.1.1 Attitudes of Farmers Towards Pain and Analgesic Use in Livestock

Sheep and cattle farmers considered prompt treatment of disease and the provision of analgesia for pain as the top two welfare considerations. Sheep and cattle farmers rated the capacity of different species to experience pain differently. There was a highly significant species effect (p<0.001) with humansa being assigned the highest scores, followed by cattleb and sheepb, and turkeys receiving the lowest scores. Overall positive attitudes to pain and analgesic use were reported: over 90% of farmers agreed that farm animals’ benefit from pain alleviation, less than 4% agreed that analgesia wasn’t necessary for farm animals and over 80% agreed that animals recover better when given analgesia. Overall cattle farmers had more positive views to pain and analgesic use than did sheep farmers (p=0.001). Farmers with more positive attitudes to pain and analgesic-use rated pain more highly (p=0.001). Sheep farmers rated the pain associated with difficult lambing, mastitis and footrot as severely painful, and normal lambing, ear marking and pregnancy toxaemia as mild to moderately painful. Common husbandry practices: castration, tail docking, dehorning and disbudding were all considered moderately painful. Farmers, vets, agricultural and veterinary students were able to distinguish between different lameness severities in sheep. Lameness was considered to be a painful condition, the pain severity increasing with the severity of the lameness. There was a significant relationship (p<0.001) between farmers and vets pain ratings and their decision to catch a lame sheep for inspection, with those assigning lower pain ratings being less likely to catch. Farmers and vets that agreed that analgesics were beneficial for the productivity and welfare of sheep were more likely to say they would treat a lame sheep with injectable antibiotics or analgesics (p<0.001). Farmers and vets that rated the pain associated with lameness more highly were more likely to use injectable antibiotics as part of the treatment (p<0.001). Farmers were more compassionate than vets (p=0.006). Females were more compassionate than males (p=0.002). Veterinarians agreed more with the benefits of analgesic use than farmers (p=0.002). Older females had the highest and young males the lowest affective empathy scores (p=0.003).

2.2.2 Acute and chronic diseases in sheep

Lameness significantly improved by day seven of treatment in sheep with footrot. Non-Steroidal Anti-Inflammatory Drugs (NSAIDS) did not have any significant effect on recovery from footrot. Lameness was positively correlated with total lesion scores. Temperature of affected feet, was significantly higher than non-diseased feet. There was no significant difference in temperature of feet with different lesion scores. Aetiology of mastitis disease interfered with the thermography readings of udders. Actigraphy allows for assessment of activity levels in sheep and can automatically monitor behavioural changes. Lame sheep were more active at night than control sheep. Lameness reduced the activity of sheep whilst walking, but not grazing. Automatic recordings detected effects of lameness better than direct observations. The ewe lamb bond is affected by mastitis. Fewer positive maternal behaviours are directed towards lambs from mothers with mastitis compared to controls. Sheep Pain Facial Expression Scale (SPFES) can accurately identify sheep with painful diseases from healthy sheep. Trained observers reliably and accurately used the SPFES to detect pain in sheep. Treatment of disease reduced the total facial pain score of adult sheep suffering from one of footrot, mastitis or pregnancy toxaemia. NSAID’s further reduced the total facial pain score of adult sheep with footrot.

Lameness was positively correlated with total facial expression pain score. We found no significant differences in cortisol levels between controls and diseased animals for all three diseases. Staph aureus, pasteurella and e-coli were the most common mastitis causing pathogens. Activin A levels did not differ between controls and sheep suffering from footrot, and levels did not differ across time. Total lesion score showed a weak trend towards positive correlation with serum activin A.
levels. Serum activin A levels were significantly increased in sheep with mastitis compared to match controls. Sheep suffering from pregnancy toxaemia did not differ to their matched controls. Significant elevations of activin A were present in all pregnant sheep for up to seven days compared to the forty two days after initial diagnosis of disease. Serum activin A may be useful for acute diseases such as mastitis but not for chronic or localised conditions such as footrot. Substance P shows a main effect of day with day 90 showing the highest values, but not of disease or any interaction between disease and time for sheep with footrot. Substance P shows a main effect of day with day 0 showing the highest values, but not of disease or any interaction between disease and time for sheep with mastitis. Substance P shows a main effect of day and a trend towards significance (P=0.06) for an effect of disease and an interaction between disease and time for sheep with pregnancy toxaemia. Days 7 and 42 differed significantly to each other but days 7 and 42 did not differ from day 0. All groups differed to each other on day 42 with the group treated with NSAIDs having the lowest level of sub-P compared to both controls and those treated without additional NSAIDs.

A preliminary Genome-Wide Association Analysis for footrot in Texel sheep was conducted using a small number of animals (n=336).

2.2.3 Acute and chronic disease in goats

A scoring table for lameness and claw overgrowth was developed to be included in the welfare assessment protocol. This scoring system was also used to develop an App in collaboration with WP4 (WelGoat) that includes training material and allows for the recording and follow up of lameness cases. Claw overgrowth and deformation can lead to chronic pain in dairy goats. Claw trimming will reduce discomfort caused by claw overgrowth. Claw trimming may not be efficient in severe and chronic deformation. Udder asymmetry is common in dairy goat farms. Some cases of udder asymmetry are correlated with discomfort at milking, suggesting some pain. Treatment of pregnancy toxaemia clinical cases is almost impossible, generally leading the death of dam and foetus. Prevention or early detection of pregnancy toxaemia cases is crucial. This may be achieved by measuring blood BHB or by detecting goats loosing body condition score.

2.2.4 Disbudding of goat kits

There are two main sources of pain in dairy farming –disease/lesions and mutilations. AWIN WP2 studied several sources of pain in goats –mastitis, pregnancy toxaemia, foot disorders and disbudding of young kids. Pain management when disbudding kids has not been widely studied because only with the increase in intensive dairy farming did it become more frequent. For anatomical reasons and because of the small head size and particular sensitivity to local anesthetics, pain management in young female kids is not as easy as in calves. On the other hand it is a short and simple procedure in which farmers do not want to spend too much time or money. We studied several methods with the aim of providing the best solution that farmers will approve and use. The perfect solution was not found, but important guidelines resulted from the studies –the best age to disbudded, instruments to use and practical ways to reduce acute pain. The other important source of pain in dairy goats is claw overgrowth and deformation. Preliminary studies showed that lameness and inflammation is present in animals that have these conditions. It was shown that almost all inflammatory and lameness signs disappear when claws are adequately and regularly trimmed. So it was demonstrated that this is a situation where farmers can actively act to reduce chronic pain in their animals. By conveying this message the AWIN team has also shown how closely welfare, health and production interrelate.

2.2.5 Castration of horse stallions

Castration of stallions is a common husbandry procedure and therefore the most frequently conducted surgery in horses. Despite this importance, there is surprisingly. The most widely (if any) used pain mitigation measure, a single perioperative application of an NSAID proved to be not effective as it was associated with significant signs of pain for up to 20 hours after surgery. Surprisingly, there was no positive effect of subsequent applications of NSAIDs. Only when the perioperative NSAID application was combined with a local anaesthesia of the spermatic cords prior to surgery, castrated stallions did not show significant signs of pain and did not differ from a control group. Based on these results, the perioperative application of a NSAID combined with local anaesthesia of the spermatic cords can clearly be recommended for effective pain control after
castration. This measure is easy to perform under field conditions, non-expensive, and can improve the welfare of castrated horses. The recommendations for post-castration pain control were disseminated to veterinary practitioners in different European countries. The assessment of equine pain based on facial expressions resulted in the “Horse Grimace Scale”, a tool (also available as an App) that raised great interest among state veterinarians, equine clinicians, horse owners but also the pharmaceutical industry. It is included in the AWIN welfare assessment protocol for horses and the also in the “Practical Guidelines to Assess Fitness for Transport of Equidae”. A method for the simultaneous detection and quantification of six equine cytokines in plasma using a fluorescent microsphere immunoassay (FMIA) was developed and validated in the AWIN Biomarkers lab. The Horse Grimace Scale as a new instrument to assess pain in horses based on their facial expressions was developed in close cooperation with WP1 and WP4. Post castration pain could be reliably detected by means of a modified Composite Pain Scale (CPS), by pain scales based on facial expressions, as well as by changes of heart rate variability (HRV). Neither one of the studied cytokines nor fecal glucocorticoids showed a significant correlation with post castration pain. Post castration pain was associated with an increase of parasympathetic cardiac activity what is in contrast to pain from most other body regions. Horse breed had no influence on their pain reaction following castration. The first day after castration is crucial for pain management. The widely used (if any) single perioperative application of a NSAID was not able to control pain effectively. Subsequent applications of NSAIDs had no beneficial effects. Only additional local anaesthesia was reducing post castration pain effectively. Pain reducing effect after local anaesthesia did last much longer than the direct duration of action of the used drug

2.2.6 Acute and chronic laminitis in horses

Acute and chronic laminitic pain could be reliably detected by means of a modified Composite Pain Scale (CPS) and by newly developed pain scales based on equine facial expressions, the Facial Expression Pain Scale (FEPS) and the Horse Grimace Scale (HGS).

Neither one of the studied cytokines nor heart rate variability measures showed a significant correlation with laminitis pain in horses. The modified CPS and the newly developed FEPS and HGS have the great advantage that no painful walking of the horse patients is required for pain assessment whereas this is needed for the widely used Obel lameness grading. With the help of CPS and FEPS it could be clearly demonstrated for the first time that orthopaedic hoof correction is associated with a reduction of pain in horses suffering from chronic laminitis. Only based on the previously used Obel lameness grading system it was not possible to differentiate between improvement of gait caused by pain relief or simply by a change of biomechanics.

2.3 The results from workpackage 3 (WP3)

WP 3 addresses the impact of the most important sources of stress during pregnancy seen in commercial herds and flocks, namely social factors such as animal density and group size in small ruminants, human handling of small ruminants, and social factors related to management of breeding mares. Controlled, experimental set-ups in WP3 have made it possible to do comparative work in sheep and goats, and the National stud in Prague gave us excellent opportunities to study important pre- and early postnatal factors in a large population of horses, which is unique. This work package has mostly focused on the effects of prenatal factors on the welfare and production of mothers and their young, but early postnatal factors were also dealt with to a small extent as some of the early work indicates that the mother may buffer the negative effects of a prenatal environment in the early postnatal period. Nonetheless, mothers tend to produce offspring adapted to the present environment, and most work on prenatal stress in farmed mammals show that the most common routines and environmental stressors in a commercial setting, can be considered as moderate stressors where we see little effects on reproductive success of the mothers or growth in offspring, but yet quite consistent effects on behavioural development of the offspring are documented irrespective of the sources of stress.

Overall, goats appears to be more sensitive to the social environment and human handling than sheep. When provided with 1 m2 per animal compared to 2 or 3 m2, ewes rested less often but in longer periods, had shorter and more frequent visits to the feeder, more social interactions, moved shorter distances, and showed a higher level of stress (i.e cortisol). Similar results were found in goats, but cortisol was not affected. Production of kids and lambs were similar in all treatments, but the prenatal
high density situation produced more fearful and proactive offspring in both species. The latter may have consequences when recruiting animals into the breeding stock since fearful animals are more difficult to handle, likely to urinate and defecate more, less likely to adapt to changes in the environment and less likely to reproduce as adults. Furthermore, early separation from the mother also increased the level of fear in lambs while mother reared lambs were less fearful, especially in the high density situation. Overall, animal density had stronger impact on behavior and welfare than group size in these two species at least within the narrow range of relatively small group sizes tested. Goats were more sensitive to negative handling than sheep. In the negative group, some goats had fetal losses, changes in placental morphology, and were less attentive towards their kids than positively handled goats. In comparison, sheep did not respond so much to any of the handling treatments, except that negatively handled ewes lambed more during the night. The latter is considered a risk in commercial herds because of less ability for human assistance during parturition, which then might affect survival.

In horses, some of the social factors were regrouping, presence of a stallion, and nursing of a previous foal until the birth of the next. The latter did not influence survival or birth weight of the new foal. Regrouping of mares resulted in elevated stress levels (i.e. heart rate and cortisol), and presence of a stallion that did not mate with the mares also increased the stress level so much that pregnancy was disrupted. In the early postnatal period, neither nursing behavior during the first, crucial 4 months nor the mothers’ dominance rank, predicted dominance rank of the foals.

2.3.1 The effects of Space allowance
2.3.1.1 Ewes
We aimed at determining the effect of space allowance on the behaviour, movement patterns and use of space, and their potential welfare implications, of dairy ewes during gestation. With this purpose, 54 pregnant ewes were randomly allocated to groups of 6 ewes with space allowances of 1, 2, or 3 m²/ewe (SA1, SA2, and SA3 respectively; 3 replicates/treatment). Behaviour was observed between gestation weeks 9 to 19. Movement and use of space data were also collected during the last 11 weeks of gestation. Regarding behaviour, SA1 ewes were less active than SA2 and SA3 ewes as indicated by reduced movement and higher % of time spent at the feeder. Occurrences of negative, and especially positive social interactions (Figure 19), were also higher for SA1 ewes, likely to higher chances to find another ewe during movement rather than of increased social conflict. A clear effect of space allowance was detected, mostly restricted to moving and eating behaviours. Nevertheless, the increased frequency of negative social interactions in SA1 ewes suggests that the highest degree of spatial restriction involved some reduction of the welfare levels of the group.

Overall, movement patterns and space use in ewes were clearly restricted by the limitation of space availability occurring in SA1 ewes. This was reflected in shorter, more sinusoidal trajectories composed of shorter steps, lower inter-individual distances and higher movement activity potentially linked with higher restlessness levels. Higher initial salivary cortisol concentrations were detected for SA1 regarding SA3, confirming that initial adaptation period was more stressful under higher space restriction. Otherwise, BCS remained unaffected by space allowance across gestation.

2.3.1.2 Lambs
After birth, lambs from each prenatal treatment remained with their mothers (MR) or were early separated (ES). Forty-two, 2 to 3 day old lambs were sequentially exposed to a novel arena, a novel object, and a social motivation test. Information on their behaviour, movement patterns, and vocalizations was collected and analysed. ES lambs born from SA1 ewes were more fearful, as indicated by the higher levels of immobility and number of vocalizations during novel arena tests, the latter being also evident during novel object tests. The behavioural response of MR lambs was more homogeneous and independent from the pre-natal treatment during novel object tests. ES SA1 lambs spent the highest % of time close to other lambs (Figure 20) and performed the highest number of vocalizations during social tests. The fear response of lambs during novel arena and novel object tests was gender dependent, with females vocalizing more and interacting more frequently with the stimulus during novel object tests. Females also showed higher social motivation than males, but vocalized less.

Brain samples from 3 newborn male lambs from SA1 and SA3 treatments were collected to study total spine density (n/μm) and counts of stubby, thin, and mushroom spines in apical and basal dendrites of pyramidal neurons from CA1 and CA3 fields, and granule cells of the DG field of hippocampus. Apical and basal pyramidal neurons from the superficial, middle, and deep
layers of the pre-frontal cortex were also studied. Total spine density in apical dendrites of CA1 hippocampus neurons was higher in SA1 lambs. On the other hand, total spine density in apical dendrites of pyramidal neurons from the prefrontal cortex was lower in SA1 lambs, mainly due to a reduction in the density of thin spines. Theses alterations may suggest that differences in the behaviour of newborn lambs according to prenatal treatments might have been mediated through modifications in the brain development before birth.

2.3.2 The effects of group size:
2.3.2.1 Ewes
We studied how group sizes of 6 or 12 ewes/pen (GS6 and GS12 respectively; space allowance of 1.5 m2/ewe; 3 pens/treatment) affected the behaviour, movement and use of space, serum cortisol concentration and body condition score (BCS) of ewes during pregnancy. Data were collected during the last 12 weeks of gestation, with behaviour, movement and use of space collected every other week using scan samplings lasting 10 minutes. Blood samples were collected during experimental weeks 1, 4, 8, 12, and BCS was collected during experimental weeks 6 and 12.
Overall, the effect of group size was milder than that of space allowance, and mostly restricted to movement and use of space, while no behavioural effects were detected. GS12 ewes walked longer distances, and in longer steps. An interaction was observed for angular dispersion, with larger trajectory sinuosity at GS12 after the initial week. Initial restlessness levels were smaller for GS12, with ewes changing less frequently pen location during initial adaptation (Figure 21). Both distance to the furthest neighbour and mean inter-individual distance increased with group size.

2.3.2.2 Lambs
After birth, lambs from each prenatal treatment remained with their mothers (MR) or were early separated (ES). A total of 32, 2 to 8 day old lambs were sequentially subjected to a novel arena, a novel object, and a social motivation test, and their behaviour, movement patterns, and vocalizations during tests were assessed. Blood cortisol concentration 1 and 6 days after tests was also determined. The effects of group size were overall weak, with GS12-MR lambs tending to vocalize more during the novel arena and novel object tests. GS6 lambs tended to forage more frequently during the novel object test, while in the social motivation tests they stood close to other lambs more frequently (i.e. in Region 3 as illustrated in Figure 22). During the novel object test MR lambs tended to forage and to look/interact with the stimulus less frequently than ES lambs. Similar evidences were found in the social motivation test with MR lambs showing lower latency to movement; they foraged and explored the pen less frequently, while they stood passive and rested more frequently. Cortisol levels after tests were also higher in MR lambs.

On the other hand, females walked longer net distances during the novel arena and social motivation tests, and tended to vocalize more in the novel arena. They also exhibited higher cortisol levels 6 days after the tests. Despite the weak effects, GS6 lambs appeared to have enhanced coping abilities to face stressful situations, and increased social motivation. MR lambs were more fearful and socially motivated, and similar results were found for females.

Similarly to previous experiment, brain samples from 6 newborn male lambs from each prenatal treatment were collected to study total spine density (n/μm) and counts of stubby, thin, and mushroom spines in both apical and basal dendrites of pyramidal neurons from the CA1, CA3 fields, and granule cells from the DG field of the hippocampus. Total spine density in apical dendrites from the CA1 field tended to be smaller in GS6 lambs, with a higher % of thin spines and a lower % of stubby spines. Total spine density in basilar dendrites from the CA1 field did not change, but the proportion of mushroom spines was smaller for GS6. Basal dendrites from neurons from the inner layer of the prefrontal cortex showed higher total spine density in the case of GS6 lambs, with the of stubby spines percentage tending to be lower and abundance (%) of thin spines tending to be higher for this prenatal treatment. Apical dendrites from neurons from the inner layer of the prefrontal cortex showed similar total spine densities, although the abundance of stubby spines tended to be higher and the thin spines lower in the case of GS6. This might be interpreted as an indication that the enhanced coping abilities of GS6 lambs were likely due to modifications in the spine density in the hippocampus and pre-frontal cortex.

2.3.3 The effects of Space allowance:
2.3.3.1 Pregnant Goats
Pregnant Norwegian dairy goats from early pregnancy until parturition were kept constantly at 1, 2 or 3 m² per animal. Their social behaviour (offensive, defensive, socio-positive), body condition, weight gain and blood cortisol level were monitored throughout pregnancy. We found that goats kept at higher density showed more offensive and defensive behaviours (Figure 23), but there was no difference in socio-positive behaviours between treatments. The increase in agonistic behaviours was not reflected in blood cortisol level, weight gain or production data. We concluded that higher frequency of agonistic behaviours are present even at 2.0 m² per animal, and if this is regarded as a sign of social stress, recommendations regarding available space per goat should be adjusted. However, keeping goats even at 1 m² per animal did not have any impact on productivity or weight development, suggesting that they easily habituate to sub-optimal environmental conditions. We also observed interindividual distance, movement patterns and activity budget in pregnant goats housed in three different densities. Results indicate close relationship between behavioural activity and interindividual distances. Goats used more space at lower density situations, where the space allowance was bigger per individual. However, whereas goats traveled lowest distances at high density moderate distance at middle density and high distances at low density (Figure 24), there was no difference in the nearest neighbor and furthest neighbor distance of goats kept at middle and low density. Findings are comparable to those in a similar study in sheep, where they observed the same space use parameters (among others) in groups of sheep kept at 1, 2 and 3m² per animal.

2.3.3.2 Kids
Prenatal effects of different herd densities on the fear responses and sociality of goat kids were studied. One kid per litter was subjected to two behavioral tests at 5 weeks of age. The ‘social test’ was applied to assess the fear responses, sociality and social recognition skills when presented with a familiar and unfamiliar kid and the ‘separation test’ assessed the behavioral coping skills when isolated. The results indicate goat kids from the highest prenatal density of 1.0 m² were more fearful than the kids from the lower prenatal densities (i.e. made more escape attempts and vocalizations; Figure 25). This effect was more pronounced in females than males in the high density and females were generally more social than males. We conclude that high animal densities during pregnancy in goats produce offspring that have a higher level of fear, particularly in females.

2.3.4 The effects of group size
2.3.4.1 Adult goats
Pregnant Norwegian dairy goats were kept in stable groups from detection of pregnancy (about six weeks after conception) until birth, and were allocated into groups of six or twenty-four (three replicates of both treatments. There was a higher frequency of defensive behaviours and a tendency towards more social activity in goats housed in large groups than goats housed in small groups. In small groups, there was a higher frequency of resting than in large groups, and goats in large groups were more active and had a higher frequency of moving and moved a larger total distance than goats in small groups (Figure 24). The distance to the “furthest neighbour” was smaller in small groups than in large groups. The goats generally had a smaller distance between individuals in the first and third time period of pregnancy where 57.7% ± 1.9%; 58.8% ± 1.8% of the behaviours performed were feeding, than during the second, where 63.7% ± 2.5% of the behaviours performed was to rest.

2.3.4.2 Kids
From 34 litters, one kid per litter (chosen randomly if twins or triplets) (19 males, 15 females; 17 kids from the small, 17 kids from the large treatment) were removed from their mother right after birth and were subjected to this study. These kids were kept in one rearing pen in a separate room from the adults and fed artificially. All the experimental kids were kept in the same pen and group. At 4 weeks of age the goat kids were subjected to a `social test` and a `separation test`.

We reported a clear effect of group size of pregnant animals on the vocalization in goat kids. Kids born to mothers of 24 animals in a group showed more vocalizations in the separation test (Figure 25), but this effect was not present in the social test. Kids born to the larger group size show more stress-related behaviours in novel environment. In general, the difference between male and female kids was smaller in large group size treatments. Sex specific effects of prenatal environment are frequently reported from neuro-morphological level to a wide range of behaviours.
2.3.5 Handling during pregnancy in sheep and goats

2.3.5.1 Ewes

One hundred twin-bearing Mule (Scottish Blackface x Border Leicester) ewes were selected from a flock supplied by SRUC’s research farm located in Midlothian, UK. Following ultrasound scanning to confirm pregnancy ewes were randomly assigned to one of five treatment groups (mid-negative – MID-NEG, mid-positive – MID-POS, late negative – LATE-NEG, late positive – LATE-POS, and minimal – M), balanced for parity and gestational age. Each treatment group contained 20 ewes split between four pens (five sheep per pen of 7m x 2m). Mid-gestation treatments were carried out between 65-100 days of pregnancy and late-gestation treatments were carried out between 100-135 days of pregnancy. There was no effect of treatment during either the mid or late periods of gestation on either salivary cortisol or faecal GM. Overall the handling treatments appear not to have a significant effect on stress physiology during either period of pregnancy on sheep. Both the salivary cortisol and faecal GM profiles suggest sheep adapt to the treatments. There were very few significant treatment effects on maternal behaviour. Only the frequency of low pitch vocalisations were significantly different during the study with any handling during the middle gestation period resulting in an increased frequency of these maternal vocalisations. There were no differences in any other maternal behaviours, other than an interesting tendency for ewes from the negatively handled group seeming to prefer to give birth at night.

2.3.5.2 Lambs

Male lamb brains weighed significantly more than females at birth (relative to body weight) however there was no effect of prenatal handling treatment on brain weight. There was a tendency for a sex by treatment interaction regarding total brain weight in the MID handling treatments; MID-POS female' brains weighed more than MID-POS male’ brains. There were no significant differences between size (normalised to total brain weight) of the hippocampus or amygdala regions of the brain, therefore relative weight of the animal’s brain did not influence the interpretation of the results.

In conclusion treatments differentially affected the sexes with no clear pattern. There were no significant effects of treatment on lamb landmark behaviours or vocalisations during the first two hours post-partum. Lamb performance in maternal recognition tests saw a significant sex by treatment interaction in bleat frequency (MID-NEG group tended to bleat more often than M group. Handling sheep at all during the middle part of pregnancy influenced maternal vocalisations. Negatively handled ewes chose quieter times (i.e. at night when less human presence in the shed) to give birth which could have implications for supervision and lamb survival. Behaviour tests were influenced by sex. Males are more vocally responsive during maternal recognition tests and lambs from ewes receiving negative handling during the middle part of pregnancy may show a compromised ability to recognise their own mother. In spatial tasks males are slower to complete a maze than females.

2.3.5.3 Goats

Forty twin-bearing Saanen x Toggenburg primiparous goats were used for the study. Between days 80-115 of gestation (gestation=150 days), goats were subjected to negative (NEG, n=13), positive (POS, n=13) or minimal (M, n=14) handling protocols for 10 minute periods twice daily. The control or minimally handled group (M) did not receive handling treatments and all goats were subjected to normal husbandry procedures outside treatment periods. Within treatment groups goats were housed in smaller groups of 4-5 goats per pen (7 m x 2 m). Salivary cortisol measured during the treatment period was higher in NEG goats over the treatment period (mean cortisol (sem) in pg/nl: NEG: 176.7 (18.2) POS: 119.6 (11.1) M: 126.5 (13.7)). NEG goats were the only treatment group to suffer fetal loss (16% loss vs 0% in POS and M). Treatment also influenced placental morphology with a tendency for fewer cotyledons evident in the negative treatment (NEG: 87.9 (7.8) POS: 107.1 (7.9) M: 112.1 (9.3)) and significantly fewer medium sized cotyledons (NEG: 67.6 (7.8) POS: 89.3 (6.4) M: 84.3 (5.4)). Cortisol was lowest in cotyledons from placentae of the negative treatment goats with possible explanation that 11β-HSD2 enzyme in placenta is converting cortisol into inactive cortisone and is more highly expressed in the negative treatment.

Overall, goats found negative handling during pregnancy a stressful experience resulting in fetal loss and changes in placental morphology. Goats that had experienced positive handling displayed more grooming and nosing behaviours towards their
young during the first two hours post-partum (Grooming: POS: 89.3% (7.1) NEG: 72.6% (7.7) M: 63.4% (9.0). Nosing frequency: POS: 58.8 (12.5) NEG: 28.6 (11.1) M: 34.7 (6.5); Figure 29).

2.3.5.4 Kids
Treatment significantly affected latency to perform play behavior, with kids from NEG goats taking on average 25 minutes longer to play for the first time than kids from POS and M treatment groups. Grooming and nosing behaviours by the mother correlated with latencies for kids to perform certain landmark behaviours, specifically latency to reach the udder (grooming: $rs = -0.378$ nosing: $rs = -0.419$) and latency to suck successfully (grooming: $rs = -0.302$ nosing: $rs = -0.345$). The delayed performance of kid behaviours indicative of neurological development demonstrates that prenatal handling stress can delay behavioural development in neonates, which may reflect a cognitive deficit that could impact upon neonatal survival.

2.3.6 Prenatal environment in horses –consequence of social environment
Pregnant mares (19 in the first and 36 in the second season) were regularly observed in calm situations as well as during social regrouping, abrupt weaning of previous foals and unpleasant procedures (vet inspections, hot-branding, hooves correction). Heart rate was measured using the synchronised Polar Team2 system®, and saliva samples were taken for assessment of cortisol levels. The foals born to the observed mares were subjected to a set of behavioural tests (startle test, novel object test) up to the age of one year. We analysed the data collected on mares in the first season with following preliminary results. We investigated changes in heart rate (HR) in domestic horse mares associated with abrupt weaning of their foals following a routine weaning procedure in group housed 9 mares. Ten non-lactating mares served as a control. We found increased heart rate associated with weaning of a previous foal and regrouping in pregnant mares. After regrouping, weaned mares showed higher HR compared to both, resident as well as new coming mares. This indicates additional negative effects of abrupt artificial weaning on pregnant mares beyond the social stress linked to regrouping.

2.3.7 Consequences of farm management and housing conditions
We investigated the impact of two different time schedules of relocation to a new environment after abrupt weaning on growth rate and saliva cortisol concentrations in a group of loose-housed domestic horses. We compared acute stress (cortisol concentrations), as well as long-term impact on weight gain indicating chronic stress in foals being moved to the new environment immediately after separation from the mothers (‘prompt relocation’) than when relocation was adjourned for a week (‘stepwise relocation’). Within two seasons, 56 foals weaned at age of 165 to 250 days were regularly weighed up to 140 days after weaning. Growth rate, as well as cortisol concentrations significantly differed between the two types of foals. In conclusion, stepwise changes of the physical and social environment within short period after abrupt weaning (deferred removal to the remote facility) resulted in lower acute stress but induced long-term negative effects on foals’ growth rate compared to joint weaning and relocation.

2.4 The main results of workpackage 4 (WP4)
By integrating applied and fundamental aspects of animal welfare research and education, the Animal Welfare Science Hub (www.animalwelfarehub.com) (ASWHub) creates a long-lasting platform that promotes synergic relationships among stakeholders and interested parties globally. The AWSHub provides farmers, veterinarians, university students, legislators, teachers and NGOs access to scientifically valid educational material and training on multiple topics free of charge. An active database of animal welfare courses on different topics is now available to students who can find on-line or face-to-face courses locally and internationally, filter the search by species, target audience, price and time requirements of programmes. Teachers and course organisers now have the opportunity to advertise their courses. Digital learning can include degree programmes available on-line as well as large-scale open courses.

Both of these models are still teaching students, however, teachers and lecturers have to build on their own teaching. As education is now moving away from standard didactic models of teaching, teachers require more interactive resources. The
AWSHub is the first educational system to host a section that is specifically dedicated to learning objects. These are simple digital units of content that are context independent, reusable and adaptable to any teaching scenario. Providing users with access to learning materials that are built through a conversational and creative process between scientists, teachers, designers and technology experts is an innovative way of teaching and disseminating animal welfare science. Learning materials hosted in the AWSHub combine up-to-date scientific content, technology, design and teaching in a non-authoritative and unbiased way to a variety of audiences. Animal welfare scientists are the core of the content production. Scientists choose the topic, the main intended audience and the basic story of what they want to get across using graphs, charts, text, photographs, animations and video clips. After defining the scientific content, the next step is to define the technology to be used. This can range from a simple Adobe Presenter or Articulate Storyline e-learning packages to a Smartphone Application. Usability testing ensures that there are no glitches and that users have a pleasurable learning experience. By combining teaching techniques with educational testing, users are ensured that they will learn what they are supposed to. The AWSHub in cooperation with the International Society for Applied Ethology (ISAE) ensure that teaching programmes are evaluated by objective expert panels based on their teaching and scientific values according to the intended audience.

Constant improvements such as building a database of high quality learning materials, an up-to-date list of specific courses and promoting networking and learning activities maximize the outcomes already generated by the AWSHub, as any new online tool requires constant use, feedback, updates and improvements to get it to work optimally and develop further. By engaging scientists with end-users prior to data collection, by disseminating knowledge not only through traditional peer-review papers and extension reports but also via learning objects, by promoting networking, interactivity and the commitment to produce clear and efficient learning materials, that are user-friendly and educationally effective, the Animal Welfare Science Hub has laid a solid foundation that paves the way for effective information exchange. The web-based system allows for a more open, discursive, interactive and collaborative environment to promote the dissemination of animal welfare science and to facilitate future synergies between the science of animal welfare and innovative media within a global network of excellence.

AWIN WP4 developed the AWIN website (www.animal-welfare-indicators.net) our public face throughout the project, and maintained and updated it. Through our website, users were able to follow the development of the project, download our newsletters as well as e-mail project members directly. We designed the main and derived logos that were used in our printed and digital materials. We also developed a sharepoint that allowed project members to exchange an unlimited amount of files. This was especially helpful for the production of our learning objects.

To meet its education mission, AWIN WP4 developed the Animal Welfare Science Hub (www.animalwelfarehub.com) a content-management system that integrates applied and fundamental aspects of education and animal welfare research into a single platform. The AWSHub, the first on its kind, is a state of the art peer-reviewed animal welfare science information repository and access point. Its development involved high or key-level stakeholders in a two-way dialogue, including government level members from all beneficiary countries, to DG SANCO/SANTE, the OIE, the UN, FAO, major non-governmental organisations, including World Animal Protection, The Brooke, Euro-group for animals, farm animal industry bodies (particularly Copa Cogeca), veterinary associations, educating bodies such as the World Veterinary Association, farmers, animal owners and keepers, veterinary and animal science students and professionals, animal welfare scientists and members of professional bodies (such as ISAE and ISAH). The AWSHub is successfully being assessed throughout the world.

The AWSHub creates a long-lasting relationship with stakeholders, allowing users to access programmes at university level whose course content includes 25% or more on animal welfare or closely related topics. Users of any level are able to search for courses that are being offered worldwide. Course organisers now are able to upload and advertise their course details and do this in their own language as well as consult our active database of animal welfare courses. After reviewing courses available, WP4 has listed courses related to any field of animal welfare and prepared them for efficient web browsing. This section of the AWSHub is unique since it is global with respect to geographical distribution and permits constant editing through a dynamic interface. The AWSHub lists information regarding 212 courses from academic organisations from around
In cooperation with the International Society for Applied Ethology (ISAE), all learning materials hosted in the Hub are evaluated by independent expert panelists. Hub learning materials have pedagogic and scientific value and are designed with the intended audience in mind. The Hub also hosts learning materials that were produced by WP4. Currently, there are 22 learning objects available to download free of charge through the Hub.

AWIN learning materials are of high quality, scientifically validated and educationally effective and derive from the research WPs of the project. AWIN successfully collaborated with animal welfare scientists from the AWIN WPs 1-3, designers and pedagogy specialists to develop this series of learning objects that have multiple audience targets (including farmers, veterinary students, children, horse owners, and adolescents). All AWIN researchers received training on video recording and photographing animals and obtaining good quality materials for the production of learning objects. AWIN researchers were trained to consider dissemination opportunities before integrating it with the science. At every stage, WP4 helped the researchers see the goal of producing clear and efficient learning materials, not just peer-review scientific journal articles. All learning objects were tested on the audience and for design features and are available in a variety of formats including video infographics, e-learning packages and smartphone apps. To date, our learning objects have received significant notoriety. For example, the Horse Grimace Scale App has had 5000 downloads and is rated as 4.8 out of 5. The recently released Welgoat App, has 50 downloads and so far is rated 4.7 out of 5. The e-learning packages about the understanding of animal pain are being used in veterinary schools across the UK and are being promoted by FVE for European schools.

AWIN WP4 also provided training to AWIN PhD students and early career post-doctoral staff in a web-based environment. Our students used an online webinar platform to present their work and debate topics such as: producing learning objects from science, understanding copyright issues, stakeholder interaction methods, careers post-PhD and effective grant writing. Our students also had the chance to present their work in webinars. In total, AWIN WP4 successfully conducted four workshops (three in person, one online) that scored highly in usefulness evaluations with the target audience.

AWIN WP4 engaged with stakeholders in many other ways beyond the Animal Welfare Science Hub. In total, WP4 members participated in conferences and events in many countries, engaged with government and non-government agencies producers and with veterinary associations, sending a clear message about the Hub and our learning materials and successfully presenting information about animal welfare evaluation.

2.5 Concluding remarks

The Animal Welfare indicators, AWIN, project completed 59 deliverables, 39 milestones in 48 months, investing 945 person months, which represented the engagement of 142 scientists, in 11 institutions in 9 countries. The project developed and tested animal welfare assessment, including pain, protocols for donkeys, goats, horses, sheep and turkeys. The project also translated the welfare assessment protocols into apps to facilitate data collection, data handling, data processing and data storage. Critical questions regarding the relationship between diseases and animal welfare were addressed, with novel protocols to assess pain in donkeys, goats, horses and sheep, integrating behavioural measures and physiological biomarkers. The project also identified limitations in some common pain mitigation processes and recognised opportunities in fostering effective strategies to address barriers to pain mitigation. The importance of the prenatal environment in modulating welfare and health outcomes was highlighted in goats, sheep and horses. In goats and sheep negative handling, low space allocation, during pregnancy compromised welfare outcomes in the offspring. Maternal behaviour was compromised in goats which received negative handling during pregnancy. Goat kids born from prenatally stressed mothers had low vitality than the offspring of positively handled animals. Poor social environment in pregnant mares and negative handling of goats compromised reproductive outcomes. The AWIN project related with stakeholders and interested parties through social media, websites and meetings involving in excess of 30,000 participants and public events which had more than 253,000 visitors. AWIN coordinated the development of learning objects, to disseminate the scientific work, totalling 22 contributions hosted in
the animal welfare science hub (www.animalwelfarehub.com). The Animal Welfare Science Hub is the largest peer reviewed portal in the world dedicated to animal welfare science. It is the goal of the partners of the AWIN project to maintain the legacy of the consortium working as a network of excellence in animal welfare science.

Potential Impact:

3.1 The overall impact of the AWIN project
3.1.1 Creation of a global network of excellence in animal welfare

The decision of the 11 partner institutions to invest in early-career scientists, Ph.D., M.Sc. and undergraduate students to help meet the AWIN project objectives allowed the consortium to establish a global network of early-career researchers who interacted effectively through their collaborative research. The success of this approach is reflected in the continuity of the activities after the end of the project for the majority of early career researchers and for the students who completed their Ph.D. training programme. Thirteen theses and dissertations were completed. The consortium reported 30 published peer reviewed articles, and a similar number of articles are currently under review. New grant applications were submitted under the ANIHWA-ERA NET Programme, Marie Curie Fellowship and country based funding bodies. The number of students engaged is evidence of the commitment of the project towards scientific training. More importantly mobility opportunities, particularly of junior scientists in the AWIN project allowed the development of collaborative research and set the stage for continuing work as a network of excellence. We list a sample of the interactions among the beneficiaries that resulted in publications or deliverables. The beneficiary Milan collaborated with the beneficiary Lisbon to develop the goat welfare assessment protocol. The beneficiary Neiker collaborated with the beneficiary SRUC, to develop the sheep welfare assessment protocol. The beneficiary Prague collaborated with the beneficiary Milan and beneficiary Havelland Horse clinic to develop and to test the horse welfare assessment protocol. The beneficiaries Cambridge, Lisbon and Havelland Horse Clinic collaborated with SRUC to develop biomarkers for animal pain. The beneficiaries Positivo and SRUC collaborated with all partners to train how to develop learning objects and prepare material for multimedia.

The beneficiary Indiana trained co-workers from the beneficiary SRUC and Neiker in staining techniques. The beneficiary NMBU collaborated with Neiker to develop protocols to assess social behaviour and space use in sheep and goats. The beneficiary Milan collaborated with the beneficiary Havelland Horse Clinic and other colleagues from Newcastle University to develop the Horse Grimace Scale. The beneficiary Neiker collaborated with the beneficiary Milan to develop the transect approach to assess turkey welfare and to develop the android based app to gather data. The beneficiary SRUC collaborated with the beneficiary Milan in the development of qualitative behavioural methodology for horses, donkeys and goats. The beneficiary Prague collaborated with the beneficiary Lisbon to use infrared thermography to assess goat welfare. The beneficiary Universidade de São Paulo collaborated with Universidade Positivo to develop strategies with the World Organization for Animal Health, OIE. The Universidade de São Paulo collaborated with the beneficiaries Cambridge, Havelland Horse Clinic and SRUC to develop protocols to measure cytokines in horse and sheep samples. The beneficiary University of São Paulo collaborated with the University of Milan and beneficiary Neiker to implement the transect methodology in Brazilian turkey farms and to develop protocols to assess early-warning indicators of challenges to turkey welfare.

3.1.2 Presence in events, fairs and others
The partners of the AWIN project participated in more than 10 large public fairs, agricultural exhibitions, science festivals and meetings, reaching over 253,000 participants where promotional videos, leaflets and other AWIN related material were distributed. Some examples are the following: Pork EXPO, 2012, Curitiba, Brazil (20,000 participants) Royal Highland Show, Edinburgh, Scotland (170,000 participants), Brazilian Veterinary Congress, Gramado Brazil (2,000 participants), World Organization for Animal Health (OIE) Conference, Foz do Iguacu, Brazil (1,300 participants). It is difficult to measure precisely the impact associated with the presence in such large events, however more than the passive sharing of material, in several of these events AWIN partners collected data on usefulness of the apps and on attitudes towards animal pain.

3.1.3 Media appearances:
AWIN partners reported more than 30 media related engagement exposure, with presence in TV programmes, radio interviews
and newspapers in the different countries.

3.1.4 Scientific events with oral presentations:
AWIN participants reported presentations in more than 200 events, over the course of the 4 year project, where they delivered contributions to audiences totalling in excess of 30,000 people in Europe, Asia, North America, Central America, South America, Africa and Oceania. AWIN results, methodologies and information availability has been made known to governments, stakeholders and scientists in many countries as a result of presentations at or for OIE, WTO, WVA, animal protection groups and animal user organisations as well as at scientific society meetings.

3.2 Specific impacts of AWIN Workpackages and species groups

1.2.1 Participation in the European equine expert committees
The European Commission DG Health and Consumers, supported by Eurogroup of Animals and World Horse Welfare, hosted a meeting of experts on the welfare of horses on 7 May 2014. The purpose of the meeting was to examine the factors affecting the welfare of horses in a diverse sector ranging from working animals to hobby animals. The meeting was attended by 67 experts representing governments and main European stakeholders active in the area of equine health and welfare. A record number of 1,747 people also followed the debate online. The meeting was part of the preparatory work for a possible animal welfare framework law. World Horse Welfare and Eurogroup for Animals worked together to organise the meeting together with EC and coordinated the publication of a detailed report, with a five year roadmap to improve the welfare of equines. AWIN partners participated in Equine Expert Meeting and helped with the follow up report, making it available the outcomes of the AWIN project, such as the horse and donkey welfare assessment protocol and the horse grimace scale. AWIN contributed with the meeting and with the final report. AWIN developed a strategic plan to deal with these challenges and worked together with stakeholders and researchers worldwide in order to develop welfare assessment protocols, training material, learning objects and apps.

1.2.2 EFSA Scientific Opinion on Sheep Welfare
AWIN partners contributed to the EFSA Panel and Animal Health and Welfare, scientific opinion on the welfare risks related to the farming of sheep for wool, meat and milk production (EFSA Journal 2014; 12(12):3933. The Scientific Opinion was published on 19/12/2014 and it is the first document addressing issues related to sheep welfare in the world. The Scientific Opinion was requested by the European Commission, question number EFSA-Q-2013-00580. AWIN participation was central to the development of the document as a result of the European Commission mandate, to the AWIN consortium, to develop science based protocols to assess sheep welfare. Farming of sheep is important worldwide, including for the EU, accounting for a global population of 1,173 million animals. In the EU there are to specific legislation for sheep welfare.

1.2.3 ANIHWA-ERA NET Consortium
AWIN worked closely with the ANIHWA-ERA NET (Animal Health and Welfare – Era Net) since its launch, in February 2012 to the definition of research priorities in the meeting held in Copenhagen, 21 and 22/11/2013. The ANIHWA ERA NET Group has the goal to approach animal health and animal welfare in their coordinated effort to sponsor high quality research.

3.2.4 Close cooperation with the World Veterinary Association
The World Veterinary Association developed a strategy action plan to regain its leadership role in animal welfare. AWIN was present from the launch of the new strategy, in the South Africa World Veterinary Congress, in 2011, to delivery of an outstanding seminar during Prague World Veterinary Congress, in 2013. AWIN helped with the development of the strategy and participated in 2 Global Webinars, in 2014. The presence of AWIN the World Animal Health Organization Conference, in December of 2013 and the presence of AWIN coordinating a full three days session on animal welfare during the Brazilian Veterinary Congress was a result of the interactions with the World Veterinary Association.

3.2.5 Close cooperation with the International Society for Applied Ethology
AWIN participated actively in all International Congresses of the International Society for Applied Ethology -ISAE, with targeted
workshops and multimedia demonstration. The ISAE is the most influential scientific society in animal welfare in the world and worked with AWIN to peer-review material submitted to the Animal Welfare Science Hub.

3.2.6 Strategies to control sheep footrot
Results from the molecular analysis for footrot undertaken by AWIN (and published in the journal 'Genetics Selection, Evolution' in 2015) have now been incorporated on the new, low density single nucleotide polymorphism ('SNP') array, (or 'chip'), that is currently being collated in New Zealand (as part of the activity of the International Sheep Genomics consortium). The scoring method for footrot (that was developed and tested, as part of a previous, related project) has been implemented in a new breeding project for the British Texel Sheep Society's elite breeding flocks in 2015, with a view to increasing the 'reference population' of animals for the implementation of genomic selection for resistance to footrot in the breed in 2016. To date, an additional 1500 animals with genotypes and footrot phenotypes have been used for this purpose, thereby building on the initial results funded by the AWIN project.

3.2.7 Close cooperation with the European DG SANTE (and DG SANCO) Office
AWIN participated of the launch of the EU Animal Welfare Strategy 2012-2015, in Brussels and in Washington DC, USA. AWIN partners also contributed with the DG-SANTE successful Better Training for Safer Food Programme as mentors in several European Countries and in South America. AWIN was present in events promoted by the DG SANTÉ Office in several countries. In Brazil, AWIN helped to develop the MOU between DG SANTÉ and the Brazilian Government, which opened up several opportunities to enhance collaborative work between Brazil and Europe in Animal Welfare.

3.2.8 Teaching resources in animal welfare
The AWIN project contributed globally with the dissemination of teaching and training material in animal welfare. The most successful partnerships were with the University of Edinburgh online M.Sc. programme in International Animal Welfare, Ethics and Law (approx. 35 new students each year) and with the Coursera, online teaching in animal welfare which reached a global audience of 58,000 students.

3.2.9 Innovative use of apps to assess animal pain and animal welfare
AWIN is the first project to develop science based apps to assess animal pain and animal welfare. The iWatch Turkey, a method based on the innovative transect approach developed in the course of AWIN project, has been used by the turkey industry in Europe, in the United States and in Brazil. The reviews of the app are very positive as it incorporates data collecting which are relevant to management aspects of the industry. The Horse Grimace Scale is freely available on Google Play Store and was downloaded more than 5,000 times and received average rating of 4.8 out of 5. The WelGoat app, develop to assess lameness in goats has been downloaded from the Google Play Store more than 100 times and has been rated 4.7 out 5. The welfare assessment protocols for goats and horses are ready and will be made available on Google Play Store.

3.2.10 Prenatal and neonatal guidelines for small ruminants and horses
Authoritative guidance on the negative impact of low space availability for sheep and goats are available from the outcomes of the project. The same applies to the handling of pregnant mares. Linking performance outcomes with behaviour, physiology and brain indicators opened a new area in animal welfare science which will yield important comparative science.

3.2.11 The Animal Welfare Science Hub
AWIN produced the first peer-reviewed animal welfare science information repository and access point: the Animal Welfare Science Hub. The AWSHub has received an enthusiastic support from non-governmental organizations, scientific societies, producers, students, policy makers among other stakeholders and interested parties. The revolutionary use of digital resources, information technology and the contribution of experts in design made the hub a unique resource. The AWSHub has been part of discussions with the European food Safety Authority, the World Animal Health Organization the International Society for Applied Ethology to develop a long term strategy for this important resource. A series of Learning Objects that successfully translate science into easy to use, valid and effective learning materials for many audience types were developed and disseminated in the animal welfare science hub. The AWIN web site has been central to the dissemination of AWIN
outcomes and the Facebook page with 944 likes and growing by approx. 16 per week.

List of Websites:
www.animal-welfare-indicators.net
www.animalwelfarehub.com

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Related information

<table>
<thead>
<tr>
<th>Result In Brief</th>
<th>Innovative portal and science based assessment protocols to promote animal welfare globally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents and Publications</td>
<td>final1-awin-publishable-summary.pdf</td>
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</tbody>
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