Innovative Tools for Assessment and Authentication of chicken meat, beef and dairy products' QualiTies

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DEM	Demonstrator, pilot, prototype	☐	**CO**	Confidential, only for members of the consortium (including the Commission Services)	☐
DEC	Websites, patent fillings, videos, etc.	☐			
OTHER		☐	**CI**	Classified, as referred to Commission Decision 2001/844/EC	☐

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1. Introduction

It is first important to explain what an EIP-AGRI Practice Abstract is. It's a summary in a common format to provide farmers, foresters, advisers or whoever is interested with short and concise practical information. As according to its website, "**The EIP-AGRI common format facilitates knowledge flows on innovative and practice-oriented projects from the start till the end of the project. The use of this format also enables farmers, advisors, researchers and all other actors across the EU to contact each other**."

In the case of the INTAQT project, the 20 Practice Abstracts (PAs) presented below are about the methodology currently implemented in INTAQT, the results of the consultations of the interactions with stakeholders and the first analytical results. More specifically, explaining the results, why it needs to be tested and what are the main benefits for the end-user if that result is implemented.

The first PA presents the context and the main objectives of the INTAQT project. PAs 2 to 4 present the methodology chosen for the main pillars of INTAQT: the multi-actor approach and the development of the farm network for the constitution of the core sampling library and for the test of innovative practices. PAs 5 to 10 are dealing with the results of the multi-actor approach; they summarize the stakeholders' expectations regarding the priority farming systems and practices to be tested in the farm networks, the priority quality traits to be measured on farm and the expectations of food labs regarding the development of new analytical tools. The PAs 11 to 19 are about the methodology developed to link the farming systems and the one quality of products and the first results the INTAQT project has produced, of which external stakeholders such as farmers, advisors, industry players, etc, can take part and benefit from. Finally, PA 20 presents the methodology implemented to boost the potential for innovation. More deliverables can be found on project's **website**.

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2. EIP-AGRI Practice Abstracts

2.1. The INTAQT project: tools to assess and authenticate poultry, beef and dairy products

Authors: B. Martin, C. Laithier, F. Leiber, R.C. Eppenstein, E. Sturaro, F. Klevenhusen, S. De Smet, M. Petracci, M. De Marchi, C.L. Manuelian, J.F. Hocquette, D. Lopes, J. Faria Anjos, M. Bondoux, C. Berri

Actors of the agri-food chain lack reliable and robust information to meet consumer expectations in relation to the multiple aspects of intrinsic quality of livestock products from the various European livestock systems. The INTAQT project aims to assess the relationships between animal production systems and products quality in order to improve husbandry practices complying with high quality animal products and sustainable farming practices. This is the "One Quality" concept. The project focuses on chicken meat, beef and dairy and applies a multi-actor participatory approach which involves all actors of the agri-food chain. The challenges are to: i) develop comprehensive models to quantify the impact of livestock systems on product safety, nutritional value and sensory attributes, ii) propose, together with the agri-food chain actors, fast, easy and cost-effective analytical tools to predict the intrinsic quality of livestock products and authenticate the associated livestock systems, iii) propose together with the same actors multi-criteria scoring tools for the intrinsic and extrinsic quality of products, and iv) promote farming practices which can allow the production of safe, healthy and tasty animal products while ensuring a decent income to farmers and respecting animal welfare and the environment. The INTAQT project (EU H2020 No 101000250 - https://h2020-intaqt.eu/) started on June 1st 2021, and has a duration of 5 years.

Figure 1: INTAQT project – one quality.

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2.2. Methodology for multi-actor approaches

Authors: F. Bedoin, C. Couzy, C. Laithier, C. Berri, B. Martin

The INTAQT project has chosen to have a participatory approach with a relative important involvement of external stakeholders: producers, processors, retailers and consumers are involved in the project in several steps. Systems to study, analysis to be made on products were not all defined beforehand by researchers: stakeholders' points of view were important for making the final decisions. Part of the budget was allocated to analysis, which stakeholders could suggest.

This methodology has been very interesting giving a good participatory dynamic to stakeholders' involvement in the research project.

In practical terms, stakeholders were selected in each country and per product in order to represent both for mainstream system or/and for a "speciality" system (PDO, organic…). They were interviewed with individually first. They were then invited to participate to national group meetings (Figure 2) and some representatives from national groups were invited to a European group meeting per product.

Besides, consumers were consulted through focus groups in 5 countries and professional labs through an online survey.

We can recommend a similar methodology to other multi-actor projects. The important points being to give the groups a real influence on the project's actions and to start with individual consultation before group discussions where power relations can be at stake. Moreover, national groups can discuss the results and be the first users.

Figure 2: National group meeting for dairy products in France, March 2022.

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2.3. Farm networks for core sampling library

Author: J. Anjos, C. Berri, B. Martin, F. Leiber, J.F. Hocquette, E. Sturaro, R.C. Eppenstein

In the INTAQT project, a farm network was built and implemented with cattle (dairy and beef) and chicken producers' in order to:

1. provide data on husbandry systems and practices, and allow sample collection of unprocessed and processed chicken, beef and dairy products from a broad regional, seasonal and typological range of husbandry conditions and propose,
2. test innovative sustainable husbandry practices.

Alongside common, conventional systems, different labelled productions, such as organic or label rouge, are considered. Each farm group represents a system within a region and consist of 5 to 6 farms, in order to realize within-system variability of the samples.

The use of this methodology provides INTAQT with a comprehensive food sample library, supplying both data on husbandry systems and practices as well as intrinsic quality measures. Moreover, it allows the testing of innovative sustainable husbandry practices aiming to improve intrinsic quality of products. In turn, this data can contribute to an increase in the added value of livestock products, via higher quality and/or more sustainable production processes.

2.4. Implementation of husbandry practices improving quality and sustainability: a living lab approach

Authors: E. Sturaro, C. Berri, D. Berry, C. Couzy, R.C. Eppenstein, C. Laithier, A. Travel, A. Cartoni Mancinelli, B. Martin, F. Leiber

The living lab approach to innovation aims to conduct research with real users. It is receiving increasing attention in the agricultural sector with a view of implementing innovations able of responding to today's environmental, economic, and social challenges.

The methodological approach is based on 5 steps implemented with regional groups of 5 to 8 farmers:

1. starting analytical phase: a critical analysis of trade-offs/synergies between sustainability and quality traits for each farm-field group;
2. decision phase: after a presentation and discussion of the results of stage 1 at meetings of the regional farmers' groups, the development of practices aimed at improving the identified synergies/mitigating the trade-offs will be proposed;
3. implementation phase: implementation of practices for at least one year. During this period, 2 or 3 meetings of the whole group of farmers on the farms will enable them to discuss their experiences, successes and problems. At this stage, researchers only have a moderating and documentation role, so as not to steer the process;
4. final analysis phase: this involves analysing the effects of implementing the practices at a final meeting of the groups of farmers and presenting the results of the analysis;
5. analysis and interpretation of the scientific data. The ambition is to establish a network of living labs that can be used as pilot and demonstration enterprises to improve practices with a view to better food quality and greater sustainability.

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2.5. Stakeholders' expectations for priority poultry farming systems

Author: M. Bourin, C. Laithier, F. Bedoin, V. Bühl, R.C. Eppenstein, A. Cartoni Mancinelli, E. Kowalski, S. McLaughlin, C. Couzy, B. Martin, C. Berri

As part of the INTAQT project, stakeholders in the poultry sector (representants of farmers, breeders, slaughterhouses, processors…) in Italy, France, Belgium and Switzerland were asked to prioritise poultry farming systems to be studied. In total, 21 systems were discussed and approved by stakeholders at national and European level. They are presented in the Figure 3 below. Some common expectations have been identified between countries: The main ones are linked to society's demands, particularly regarding animal welfare and environmental issues. They also linked to the expectations of consumers' who want final products that are safe, traceable and in line with market demand.

Regarding the rearing system to be analysed as part of the project, stakeholders agreed on the importance of including practices representative and specific of each country, but also some of common interest such as the Best Chicken Commitment (BCC), indoor farming system with fast-growing chickens, free range farming and also future indoor farming system offering natural light, environmental enrichments, reduced density…

Stakeholders accepted the proposals made (Figure 3). However, during the discussions at the meeting, three new proposals were suggested for further evaluation during the living lab stage of the project:

- Underfloor heating linked to footpad dermatitis and bird behaviour.
- Early feeding at the hatchery or through on-farm hatching.
- Veranda for slow- and medium-growing chickens

We were also reminded of the importance of collecting information on the slaughter process, such as the carcass cooling method, which has a significant impact on meat quality.

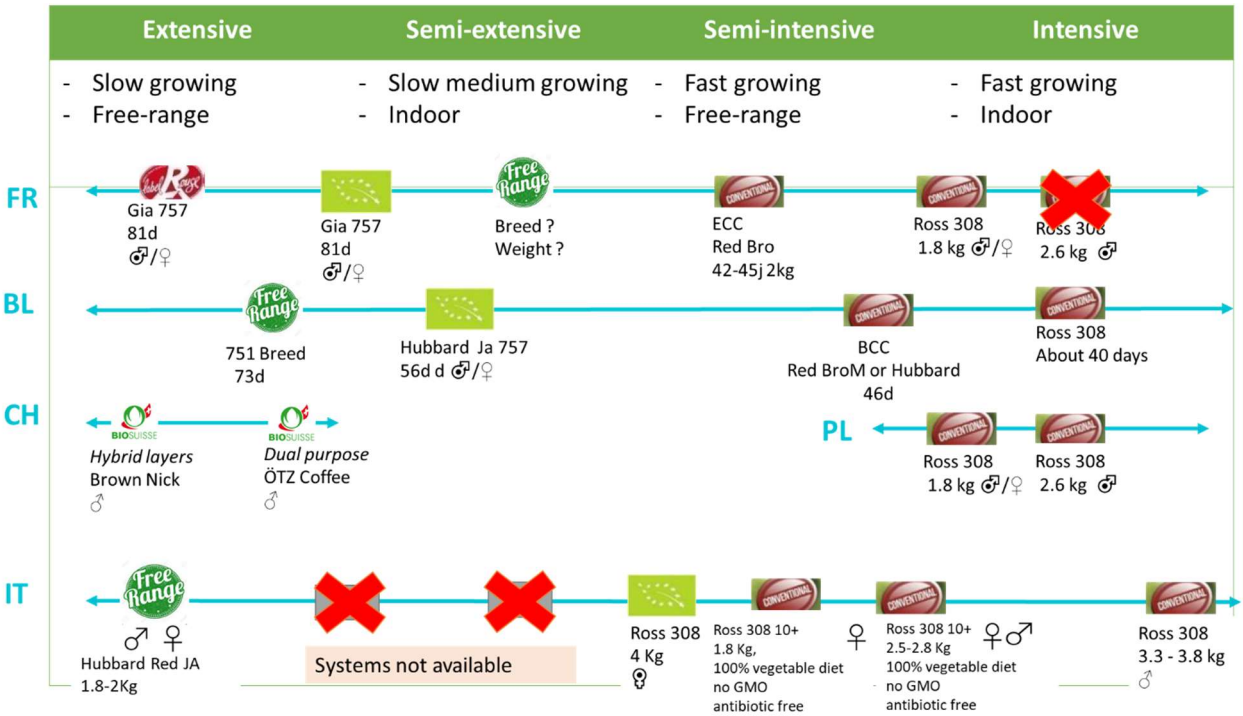

Figure 3: Final poultry systems studied in INTAQT including stakeholder recommendations, France (FR), Italy (IT), Belgium (BE) and Switzerland (CH).

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2.6. Stakeholders' expectations for priority dairy farming systems

Authors: F. Albert, R.C. Eppenstein, V. Bühl, I. Legrand, A. Nicolazo de Barmon, C. Laithier, M. Berton, M. Bourin, A. Cartoni Mancinelli, D.A. Kenny, E. Kowalski, S. McLaughlin, G. Plesch, F. Bedoin, C. Couzy, C. Berri, B. Martin

In the INTAQT project, dairy stakeholders (farmers, processors and cheesemongers) and citizens from Ireland, Germany, Italy and France were asked to prioritize dairy farming systems to be studied. In total, 16 systems were discussed and validated by the stakeholders at national and European level. Their diversity is detailed in Figure 4. Some common expectations were identified:

- Including practices that improve farms' self-autonomy and reduce external inputs,
- Including systems using grazing,
- Considering animal welfare and environmental issues,
- Considering circular economy.

Concerns about feeding were raised in all of the countries involved in the project. Specific demands included the studying of maize-based systems, the studying of grass and hay-based systems, the recording of concentrate feed levels, and the impact of local forages.

Some remarks were common across countries. Italy, Switzerland and Germany, were interested in studying the use of crossbreed and dual-purpose breeds. Irish and French stakeholders were interested in studying different milking systems, including robotic milking.

Other expectations were specific to each country. These concerned social aspect (France, Germany), herd structure and management (France), breeds and genetics (Switzerland, Italy), animal welfare (Italy), and the study of raw milk products (Italy and PDO actors in France).

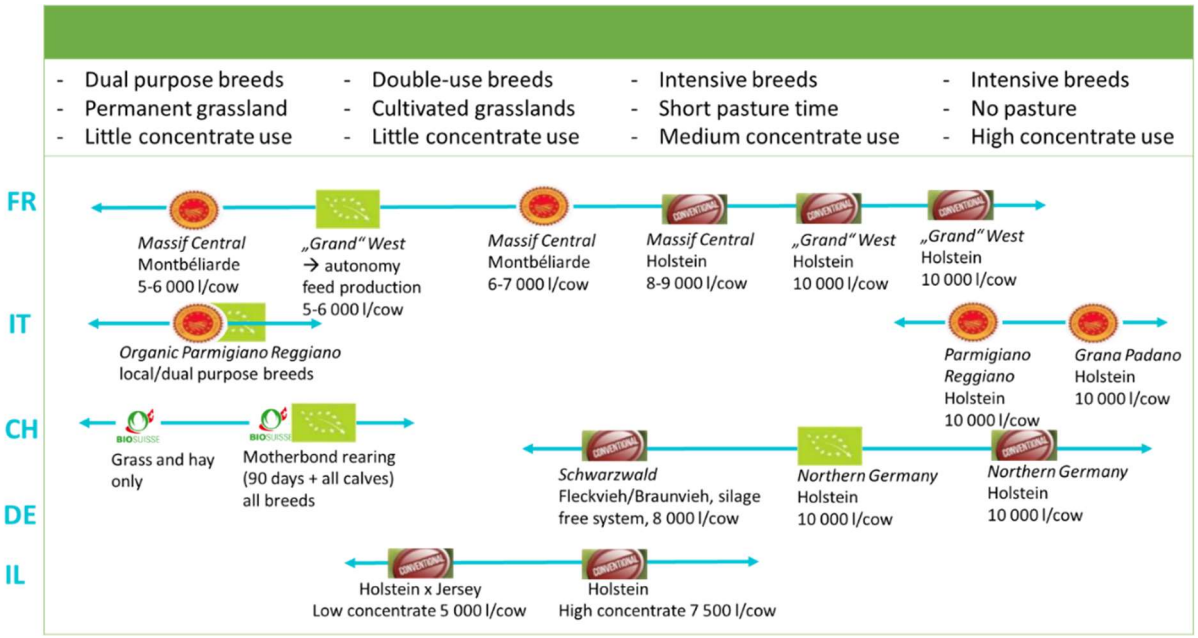

Figure 4: A diversity of dairy systems studied in INTAQT, France (FR), Germany (DE), Italy (IT), Ireland (IL) and Switzerland (CH).

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2.7. Stakeholders' expectations on beef husbandry systems and innovative practices

Authors: A. Nicolazo de Barmon, I. Legrand, C. Denoyelle, R.C. Eppenstein, M. Berton, S. McLaughlin, F. Bedoin, C. Laithier

One of the aims of the INTAQT project is to evaluate the impact of innovative husbandry practices on beef quality. A participatory approach with external stakeholders: producers, processors, retailers and consumers was carried to select which husbandry systems to study in the project. In total, 55 face-to-face interviews took place in France, Italy, Switzerland and the UK between November 2021 and March 2022. This was followed by a national meeting in each country and then a European group meeting. Stakeholders were asked to react to a preselection of husbandry systems and to complete it to reach the 12 planned systems for beef (see Figure 5). They also had to give ideas of interesting innovative practices to be tested. Stakeholders of all value chains agreed with the initially selected systems. Suggestions covered both mainstream systems as well as new, innovative ones, which are emerging due to the growing societal rejection of intensive farming practices. Most stakeholders wanted to include systems based on grass use, that could improve the farms' self-autonomy, animal welfare and environmental impact. Furthermore, actors suggested innovative practices about feeding, husbandry practices and genetics. The mains topics mentioned about practices were economic resilience, product quality, environmental and animal welfare and reflected a wish to better answer to consumers expectations.

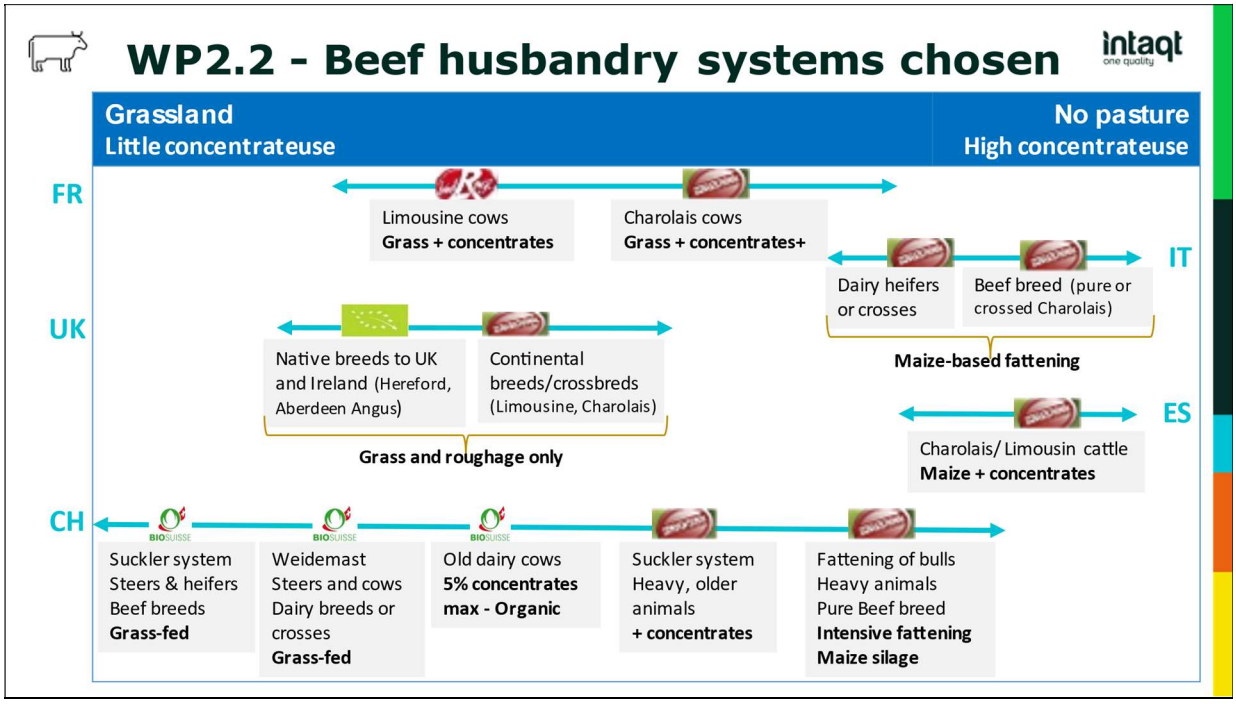

Figure 5: Final beef husbandry systems studied in INTAQT including stakeholder recommendations, France (FR), Italy (IT), Spain (SP), United Kingdom (UK) and Switzerland (CH).

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2.8. Stakeholders' expectations for priority quality traits - Dairy - Beef - Poultry

Author: C. Laithier, F. Bedoin, F. Albert, I. Legrand, A. Nicolazo de Barmon, M. Bourin, M. Berton, V. Bühl, R.C. Eppenstein, A. Cartoni Mancinelli, D.A. Kenny, E. Kowalski, S. McLaughlin, G. Plesch, C. Couzy, C. Berri, B. Martin

In the INTAQT project, stakeholders from the poultry meat, beef and dairy sectors were asked about their expectations concerning product quality in order to prioritize the quality traits considered in the project. These stakeholders involved producers, processors, retailers and some representatives of citizens' associations. In addition to the intrinsic quality criteria already foreseen in the project (health, nutrition, organoleptic), stakeholders spontaneously expressed the importance of considering extrinsic quality criteria related to sustainability (animal welfare, environmental impacts and socio-economic aspects) as well as technological quality. For the evaluation of environmental impacts and animal welfare, in addition to the measurements based on surveys and observations made on-farm, the development of specific methodologies is expected too on the products, especially for milk and beef. Socio-economic aspects encompass farmers' income (dairy), added value for the food chain (beef); good working conditions, link to the origin (beef, milk), information on price (chicken) and willingness to pay (dairy). Stakeholders are expecting some specific analyses related to the technological issues in the concerned sector. The other criteria were mentioned in a variable way depending on the type of stakeholder, the country and the sector concerned. These results are consistent with consumers' views, and they have been taken into account in the project.

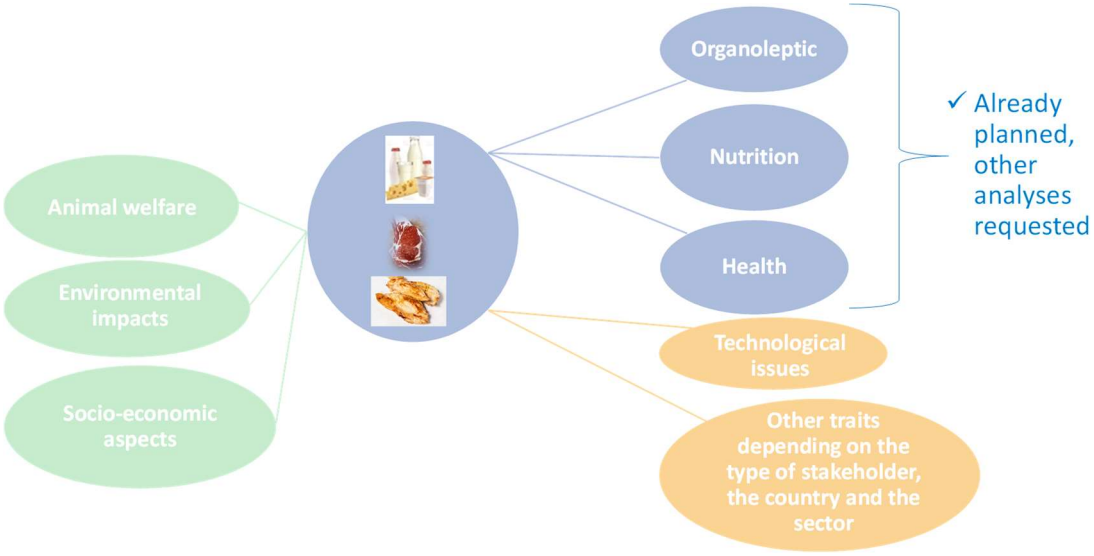

Figure 6: Stakeholders' expectations for priority quality traits - Dairy - Beef – Poultry.

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2.9. Stakeholders' opinions on future multicriteria scoring tools for animal products

Authors: I. Legrand, A. Nicolazo De Barmon, F. Albert, M. Berton, M. Bourin, V. Bühl, A. Cartoni Mancinelli, R.C. Eppenstein, D.A. Kenny, E. Kowalski, S. McLaughlin, G. Plesch, F. Bedoin, C. Couzy, C. Berri, B. Martin, C. Laithier.

Agri-food chain actors (AFAs) lack reliable information to meet consumer expectations in relation to multiple facets of intrinsic quality of chicken meat, beef, and dairy products from the various European livestock systems. One of the challenges of the INTAQT project is to build, with AFAs, multi-criteria scoring tools related to products global quality. This tool should combine safety, sensory, and nutritional results obtained during the project-based on collection of poultry/beef/dairy samples and possibly other quality criteria. Multi-actor participatory approach was applied to present and discuss the concept of a multicriteria scoring tool, collecting opinions, fears, and expectations on this tool. On a consumer side, it was felt that such a multi-criteria score placed on products could be a clear and simple representation of a complex reality. However, some disadvantages were expressed about its reliability or implementation. For their part, AFAs had varying opinions on the tool's target, mainly about its possible use as an internal tool or for consumer information, with different pros and cons expressed on both aims. Fears dealt with the building of the tool, and its relevance, representativeness, practical use, and the potential dangers, especially if safety aspects were included. However, both consumers and AFAs agree on the need to include in this tool extrinsic criteria such as farming system sustainability and animal welfare.

2.10. Food labs' expectations for rapid analytical tools

Authors: S. McLaughlin, F. Albert, F. Bedoin, C. Couzy, I. Legrand, A. Nicolazo De Barmon, C. Laithier, C.L. Manuelian, F. Klevenhusen, S. De Smet, E. Sturaro, N. Scollan

There is a need to develop innovative and cost-effective analytical tools to enable i) the authentication of husbandry systems with different levels of intensification and of animal breeds and strains, and ii) the prediction of intrinsic quality traits of milk and dairy products, beef, and chicken meat. It is important to obtain an overview of current prediction and authentication tools used and needed in European livestock product chains. Thus, a quantitative and qualitative online survey was administered to laboratories, processors, advisors, and retailers in France, Germany, Italy, and the UK. Of the 93 responses with 42 completed reports were obtained for all survey modules. The results of the online survey revealed that pathogen and microbiological quality analyses are widely used by the industry. Authentication methods were used most commonly to assess specific processes (e.g., meat cuts, ageing of meat, heat treatment used for milk). In total, 56% of the respondents are currently using near-infrared (NIR) and/or mid-infrared (MIR) devices. There is great interest to develop tools and methods that rapidly assess pathogens, antibiotic resistance, antibiotic residues, and shelf life as the quality parameters of interest. However, developed tools must have the correct software and calibration to enable laboratories and companies to use such devices. The cost of rapid analytical tools and equipment in terms of accessibility to end user should also be considered. To conclude, there is a need within livestock product chains for novel, rapid methods to assess and authenticate product quality.

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2.11. Intrinsic quality traits studied in INTAQT – Poultry

Authors: C. Berri, S. De Smet, M. Petracci, F. Klevenhusen

The INTAQT project aims to assess the relationships between animal production systems and products quality in order to improve husbandry practices complying with high quality animal products and sustainable farming. This is the "One Quality" concept. The project focuses on chicken meat, beef and dairy and addresses the various facets of intrinsic quality, namely the safety, nutritional value and organoleptic qualities of products. In the case of chicken meat, and following consultation with stakeholders in the sector, it was decided to also consider the technological quality of the meat, in particular its ability to be processed and stored, and some specific measures related to antibiotic resistance and amino acid digestibility.

The following quality traits will be assessed on poultry samples:

- for safety: microbial contamination (faeces) and antibiotic resistance genes; presence of dioxins, polychlorinated biphenyls (PCBs) and furans, mycotoxins and per- and polyfluoroalkyl substances (PFAS) (liver), and heavy metals (breast and leg);
- for nutritional value (breast and leg): proximal analysis (water, protein, fat), fatty acid composition, minerals and trace elements, vitamins A, B, D, E, histidine dipeptides, collagen, haem iron; for breast only, amino acid profile and digestibility;
- for organoleptic quality: sensory evaluation by trained and consumer panel and instrumental analysis (colour and shear-force value);
- for processing and storage ability: pH, breast muscle myopathies, drip and cooking loss, curing-cooking yield (breast) and lipid peroxidation (breast and leg).

These measurements (example in Figure 7) will be used to qualify products by type of production system, as well as to develop high-throughput prediction tools, based on complementary measurements using spectral technologies (infrared and metabolomics).

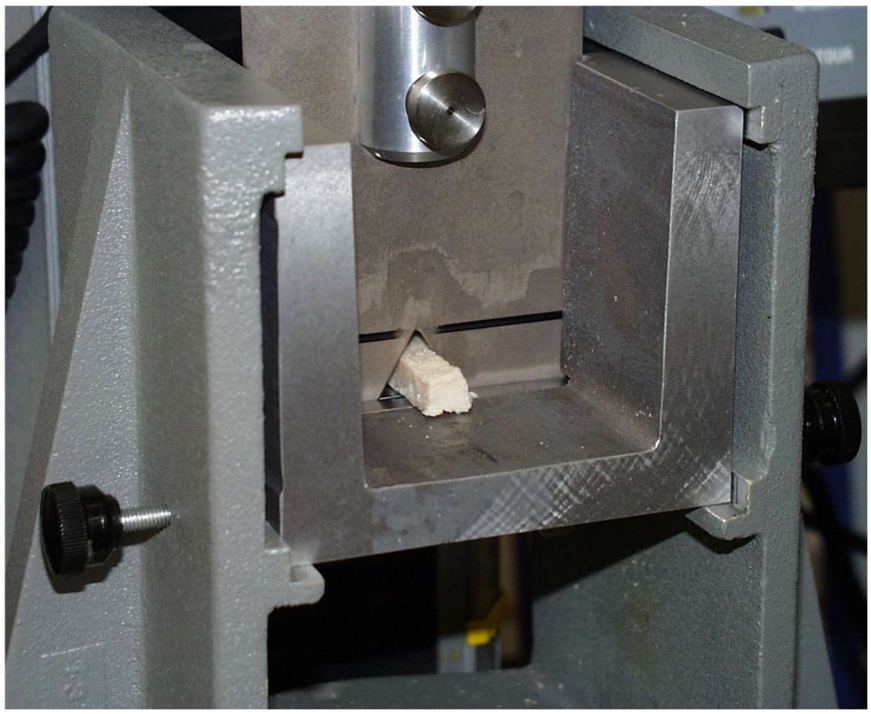

Figure 7: Shear force measurement on chicken breast.

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2.12. Intrinsic quality traits studied in INTAQT – Milk

Authors: B. Martin, S. De Smet, M. Petracci, F. Klevenhusen

The INTAQT project aims to assess the relationships between animal production systems and products quality in order to improve husbandry practices complying with high quality animal products and sustainable farming. This is the "One Quality" concept. The project focuses in particular on the various facets of the intrinsic quality of milk (safety, nutritional value and organoleptic qualities) important for consumers. Following consultation with stakeholders in the sector, it was decided to also consider some quality traits related to its ability to be processed and some specific measures related to the microbial communities and volatile organic compounds.

The following quality traits will be assessed on milk samples:

- for safety: presence of dioxins, polychlorinated biphenyls (PCBs) and furans, mycotoxins and plant toxins, per-and polyfluoroalkyl substances (PFAS) and heavy metals;
- for nutritional value: proximal analysis (protein, fat, lactose, urea), fatty acid composition, phospholipids, protein fractions and variants, minerals and trace elements and vitamins B and E;
- for organoleptic quality: sensory evaluation by trained and consumer panel of liquid milk (UHT and pasteurised), instrumental analysis of colour and volatile organic compounds;
- for processing ability: total bacterial count, microbial diversity, presence of inhibitors, freezing point.

These measurements will be used to qualify products by type of production system, as well as to develop high-throughput prediction tools, based in particular on complementary measurements using spectral technologies and untargeted metabolomics.

Figure 8: On-farm milk sampling for analyses

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2.13. Intrinsic quality traits studied in INTAQT – Beef

Authors: J.F. Hocquette, I. Legrand, A. Neveu, S. De Smet, M. Petracci, F. Klevenhusen

The INTAQT project aims to assess the relationships between animal production systems and products quality in order to improve husbandry practices complying with high quality animal products and sustainable farming. This is the "One Quality" concept. The project focuses on chicken meat, beef and dairy and addresses the various facets of intrinsic quality, namely the safety, nutritional value and organoleptic qualities of products. In the case of beef (Figure 9) most measures will be made on tenderloin, and following consultation with stakeholders in the sector, it was decided to also consider specific measures related to antibiotic resistance bacteria (E. coli in particular).

The following quality traits will be assessed on beef samples:

- for safety: antibiotic resistant bacteria; presence of dioxins, polychlorinated biphenyls (PCBs) and furans (meat and liver), mycotoxins and plant toxins (liver) and per- and polyfluoroalkyl substances (PFAS) (liver), heavy metals (meat); spoilage microbial flora (meat);
- for nutritional value: proximal analysis (water, protein, fat), fatty acid composition, minerals and trace elements, vitamins A, B, D, E, histidine dipeptides, collagen, haem iron;
- organoleptic quality: sensory evaluation by consumer panel and instrumental analysis (pH, colour, and shear-force value); lipid peroxidation

These measurements will be used to qualify products by type of production system, as well as to develop high-throughput prediction tools, based in particular on complementary measurements using spectral technologies (infrared and metabolomics).

Figure 9: Beef meat cut for analyses

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2.14. Carcass characteristics to assess the eating quality of beef meat

Authors: R.C. Eppenstein, A. Neveu, J.F. Hocquette, I. Legrand, M. Adamczyk, J. Wierzbicki

The Australian Beef Chiller Assessment System (ABCAS) is a specific carcass grading system used in the INTAQT project to assess the eating quality of beef meat. It is a carcass grading system, which aims at predicting tenderness, juiciness, flavour and overall liking of a beef cut for consumers, through the assessment of carcass characteristics in the slaughterhouse. As a result of the carcass assessment, each individual cut is assigned a quality grade, ranging from “Good”, “Premium” to “Supreme”. The quality grades satisfy consumer expectations of a corresponding meal occasion and thus guarantee consumers with an enjoyable eating experience. The quality grades of individual cuts may be aggregated at carcass level.

The characteristics used for the classification of carcasses pertain to the animal and fattening system, to the rib eye muscle and to post-slaughter processes. Characteristics pertaining to the animal are sex, carcass weight, the maturity of the carcass based on its ossification, the feed (weaned vs milk fed veal) and the percentage of bos indicus / hump height of the animal. At the ribbing site, the amount of marbling, the fat depth, the colour of meat and fat, and the size of the rib eye muscle are assessed. Lastly, regarding the slaughter process the carcass hanging method, the fat cover or hide puller damage, the carcass temperature, ultimate pH and the number of days the carcass has been aged, are taken into account.

Carcass assessments are conducted by trained assessors and require the use of standardized techniques and equipment.

Figure 10: Evaluation of the carcass in the IMR3G Foundation and INRAE training session in Spain (17/02/2022).

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2.15. Chicken breed authentication using DNA

Authors: R. Rouger, D. Berry, C. Berri

Label Rouge certification is a French quality stamp distinguishing products of higher quality. The specifications of Label Rouge chicken meat products include the use of slow growing lines. The list of the lines that are eligible for Label Rouge certification is published by INAO (Institut National de l'Origine et de la Qualité). These tasks aim at using molecular genetic tools in order to control the line that is used for the production of a randomly selected Label Rouge chicken meat product. A sample library of all the parental lines listed within the INAO catalogue and currently distributed by breeding companies will be gathered. DNA from these lines will be extracted and genotyped using a 10 000 SNP chip developed within the H2020 IMAGE project. In parallel, test samples of both Label Rouge and standard products will also be collected, their DNA extracted and genotyped. For any given test samples, its likelihood of belonging to any of the Label Rouge line will be calculated using classical population genetics methods. This value will then be compared to the simulated likelihood distributions that are expected for any Label Rouge line. This analysis should hopefully permit us to either assign or exclude the test sample to any Label Rouge line (Figure 11). Ultimately, this task will deliver a ready-to-use test for food quality control services and protect breeding companies against the risk of counterfeit Label Rouge products.

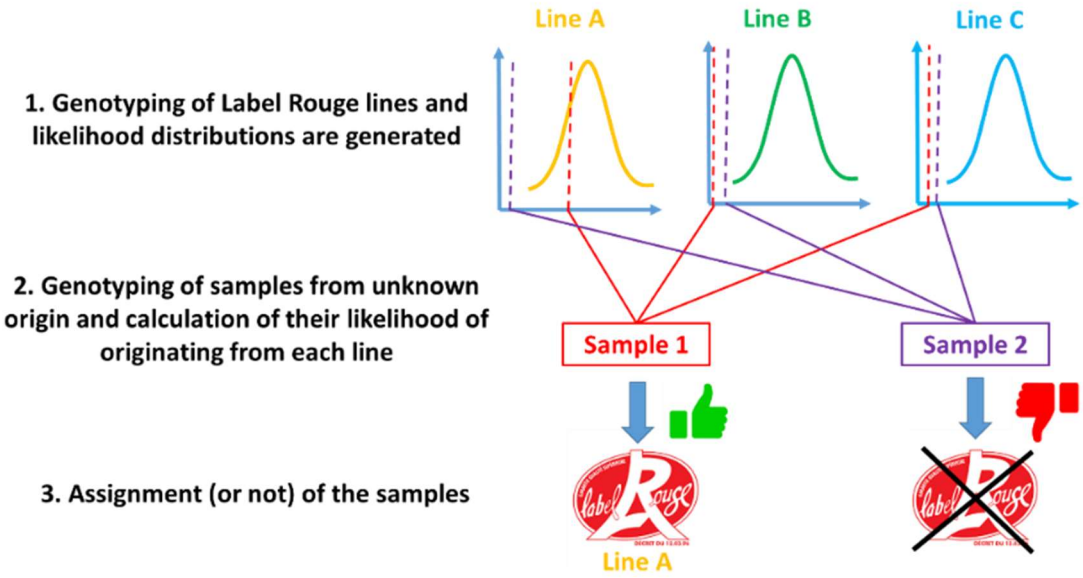

Figure 11: Principle of the ready-to-use test for Label Rouge line control

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2.16. Potential of milk infrared spectroscopy to discriminate farm characteristics

Authors: M.A. Ramirez Mauricio, D. Giannuzzi, L. Gallo, M. Berton, A. Cecchinato, E. Sturaro

The Fourier-transform infrared spectroscopy (FTIR) is one of the most developed and implemented tools for the analysis of milk chemical compounds. Besides this, FTIR can also be used to determine the fingerprint of milk for authentication purposes to certify the area of origin or the farming system in which the milk is produced. The study aimed at assessing the effectiveness of FTIR applied to bulk milk samples in discriminating dairy herds of Parmigiano Reggiano Consortium (PRC) for their structural and management characteristics. Dairy farm information included altitude zone (AZ), herd size (HS), housing type (HT), dairy cows' genetic type (GT), use of total mixed rations (MR), and proportion of concentrate in the cow diets (CONC). This database was merged with milk data obtained from the official milk recording system along with FTIR spectral data of bulk milk, stored by the Breeders Association of Emilia Romagna Region lab (ARAER, Reggio Emilia, Italy) from January to August 2022. Overall data set comprised 4,610 bulk milk FTIR spectra from 940 farms, with a mean of 4.9 (± 1.1) observations per farm respectively. Mathematical models were fitted to estimate the probability of each observation (i.e., farm) belonging to a specific group (e.g., AZ, HS, etc.). Finally, the models developed gained an accuracy of 85%, 74%, 86%, 82% and 97% for classifying the proportion of CONC, AZ, HT, MR and GT respectively. These results suggest the potential of FTIR to determine the fingerprint of milk for authentication purposes in the PRC area.

2.17. Pocket near-infrared spectrometer to predict beef marbling

Authors: M. Kombolo Ngaha, A. Goi, M. Santinello, N. Rampado, S. Atanassova, J. Liu, P. Faure, L. Thoumy, A. Neveu, J. Andueza-Urra, C. L. Manuelian, M. De Marchi, J.F. Hocquette

The Meat Standard Australia (MSA) grading system predicts beef eating quality, but it requires regularly trained graders in slaughterhouses. Marbling is one of the most important parameters evaluated and refers to intramuscular fat. Near-infrared (NIR) spectroscopy is already used in the food industry to assess gross composition such as fat and protein content in meat and dairy products. Recently, NIR pocket-size devices are available in the market at a reasonable cost allowing to be used in-line at the slaughterhouse. The study aimed to assess the feasibility of a NIR pocket-size to predict marbling score on intact meat muscles in the chiller. From 2 slaughterhouses in France and Italy, 829 commercial beef carcasses from different breeds, ages and weights were graded. The reference values were the marbling scores assessed at 24 h *postmortem* according to the 3G (Global Grading Guaranteed) protocol. The NIR spectra were collected by performing 5 scans per sample at different points of the *Longissimus thoracis*. Both information (reference value and spectrum) were matched to build the prediction models. The average MSA marbling score obtained was 330–340 in the two countries. The prediction models provided a coefficient of determination in external validation between 0.46 and 0.59 and a standard error of prediction between 83.1 and 105.5. The study also categorized carcasses into three classes (Low, Medium, and High) based on breed and sex or without considering these features with a similar accuracy rate of approximately 61%. This study suggests that using a portable device for predicting MSA marbling classes could be a relevant approach for the industry.

Find more information in the recently published paper: https://doi.org/10.1016/j.meatsci.2023.109169

Figure 12: Pocket near-infrared spectrometer to predict beef marbling

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2.18. A new methodology for optimising the quality of animal products based on rearing practices

Authors: J. Albechaalany, M.P. Ellies-Oury, J.F Hocquette, C. Berri, J. Saracco

Livestock products are a highly nutritious food source, hold an important role in the global economy. However, consumers are increasingly aware of the impact of farming systems on animal welfare and the environment, and there is a strong demand for farming practices to evolve to meet these expectations. However, it is essential to ensure that these changes do not come at the expense of product quality, and there is still a lack of information on the impact of changing practices on intrinsic product quality (particularly health, nutritional and organoleptic quality).

One of the aims of the INTAQT project is to develop methodologies for predicting and optimising the quality of animal products based on farming practices. To achieve this objective, a multi-objective algorithm (Figure 13) is being developed, to select the best rearing practices according to pre-defined quality objectives. The decision space is defined by variables related to the management of breeding practices, while the objective space represents variables related to the quality parameters we are seeking to optimise. Using this approach, we can generate the best breeding practices for each breed/type of animal and optimise quality.

This updated methodological approach should eventually make it possible to estimate the quality of products on the basis of their rearing practices. Furthermore, it serves as a valuable decision-making tool for breeders and production organizations, enable them to improve quality in line with consumer demands.

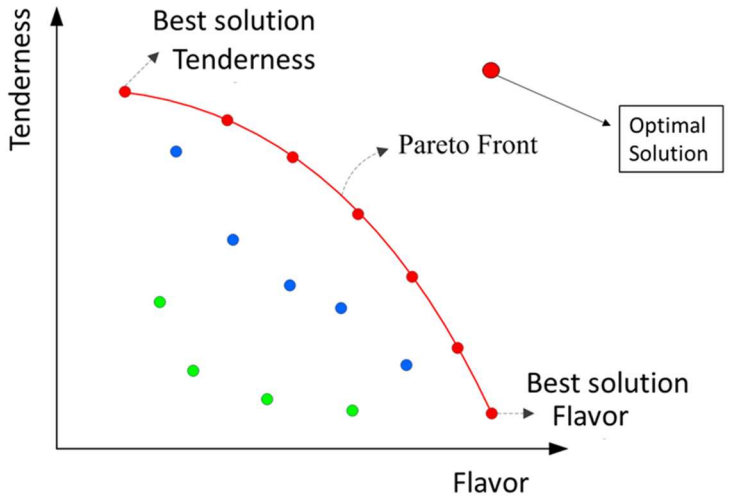

Figure 13: Multi-objective algorithm to select the best rearing practices according to pre-defined quality objectives.

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2.19. The regression tree method: a new methodology to be implemented in INTAQT to link farmers' practices and products' One Quality

Authors: L. Rey-Cadilhac, A. Ferlay, M. Gelé, S. Léger, C. Laurent

In previous studies, INRAE and VetAgro Sup developed a multicriteria scoring tool of the overall intrinsic quality of milk and a specific methodology to link farmers' practices and scores related to product quality. These methodologies could be adapted to the questions tackled in INTAQT and extended to the beef and poultry sectors. The multicriteria assessment allowed to consider about 30 indicators from the analyses carried out on milk, which, when aggregated, gave scores (from 0 to 10) of the 4 dimensions (sensory, technological, nutritional and health) of the intrinsic quality and of the overall intrinsic quality. This assessment was implemented for 2 targeted products: raw milk cheese and semi-skimmed ultra-high-temperature milk. These indicator values, dimension and overall intrinsic quality scores were then predicted from combinations of farming practices using the regression tree method. Regression trees allowed to identify the combinations of practices that lead to the best indicator values, dimension and overall intrinsic quality scores, and to prioritize the importance of these practices. By comparing the trees, it was also possible to determine synergistic and antagonistic effects of farming practices among the different indicators, dimensions and targeted products. This method could be adapted to the "One quality" concept developed in INTAQT by considering both extrinsic aspects of quality in order to determine the trade-offs to be made among different quality aspects.

Find more information in the published papers: https://doi.org/10.3168/jds.2022-22486 and https://doi.org/10.1016/j.animal.2021.100264 ;

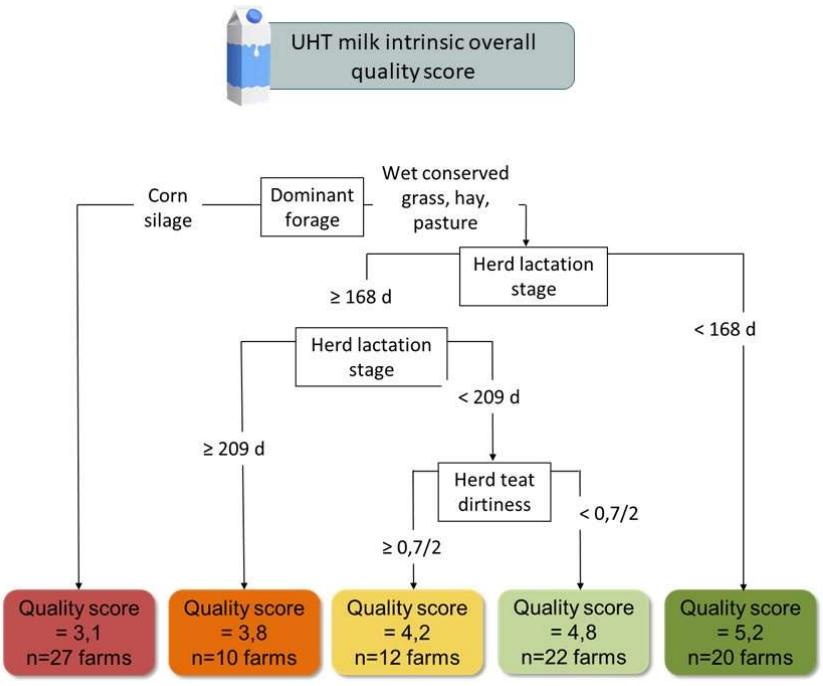

Figure 14: Example of decision tree developed for UHT milk overall intrinsic quality scores.

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2.20. Capacity building to boost the potential for innovation

Author: Faria Anjos J.

A training package will be developed based on a blended training approach which can be adapted to national needs and local contexts, as well as different target-segments profiles. The objective is to train on the use of the multi-criteria scoring tools (web application) developed and on proposed innovative husbandry practices, complying with high product quality, in order to improve their capacity on standards for animal production, sustainability and quality assessment. Participants in these workshops will be members of quality schemes and will act as a proof of concept, giving their inputs and validating the applicability of these tools. The use of online tools to organise virtual training sessions will be considered, if necessary, in line with potential limitations caused by COVID-19, replacing some of the face-to-face events initially scheduled. The training modules will be produced in English and consolidate existing training guides and best practices, incorporating innovations developed in INTAQT.

The use of this methodology will benefit mainly farmers and advisors, contributing towards their capacity building in order to boost their potential for innovation and to develop new quality driven and more sustainable animal production chains.

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3. Conclusion

International Meat Research 3G Foundation, as the responsible partner for the production of the PAs, has already contacted the entity responsible to streamline its publication in EPI-AGRI and CAP Network databases. Furthermore, and to ensure a wider dissemination of these abstracts, they will also be added to the INAQT website in a dedicated section.

The next batch of Practice Abstracts is due in M59, as part of the D6.6 Practice Abstracts – Batch 2, and will present the latest outputs of the project.

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