Abstract

EFSA aims to develop a quantitative risk assessment methodology to assess the welfare of the animals by applying animal-based measures (ABMs).

In the last ten years, quite a number of resources were committed in the EU for improving the scientific knowledge on the use of ABMs, and these measures were identified as possible tools to be used as “diagnostic tests” for animal welfare (AW); however they are not consistently used and standardised.

The aim of this project was to establish what has been achieved and what is still missing on the use of ABMs. A review and analysis of the research findings and quality assurance programs (QASs) in the EU on the use of ABMs during the past ten years were carried out in order to define the state of play, assess how the concept and the use of ABMs have penetrated the AW community and identify the gaps that may have affected the use of ABMs in risk assessment. Additionally, it was of interest to assess how the scientific outcomes have been included into the legislative framework.

An ad-hoc working-group was set up to support the activities of the project, which were mainly outsourced. The level of penetration of ABMs was calculated for EU-funded projects, peer-reviewed papers, EU-legislation and QASs, whereas gaps were identified in the case of the projects, papers and QASs. A first statistical analysis was carried out, followed by experts’ discussion and guided brainstorming analyses.

This report summarises the results of the gap mapping analysis and the outcomes of the experts’ discussion. It also reports on the main actions that have been identified in order to fill the gaps, enhance and spread the use of ABMs among stakeholders and interested parties, and develop quantitative risk assessment methodologies in AW using ABMs.

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Key words: Animal-based measure; ABM; animal welfare; penetration level; gap mapping analysis; animal welfare community; data repository.

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Summary

EFSA aims to develop a quantitative risk assessment methodology to assess the welfare of the animals by using, among other tools, animal-based measures (ABMs).

In the last 10 years, quite a number of resources have been committed in the EU to improve the scientific knowledge on the use of ABMs, and these measures have been identified as possible tools to be used as “diagnostic tests” for animal welfare (AW). However ABMs are not consistently used and standardised.

To understand what has affected this, on the basis of previous experience, EFSA carried out an internal project to identify, define and analyse the main gaps as well as to involve experts in order to discuss the outcomes and suggest possible solutions or further activities to overcome the gaps.

The overall objective was to describe the state of play on the use of ABMs to assess AW in the EU - what has been done, what is still missing and which actions will be needed in order to optimize the resources for further projects in animal welfare. This was done by assessing the level of penetration of the concept and the use of ABMs in AW community, as well as by delivering a gap mapping analysis of the activities on the use of ABMs that have been carried out in the past ten years in the EU. Four animal-welfare related areas of interest have been considered in the project: EU-funded projects, peer reviewed papers, EU-legislative acts and Quality Assurance Schemes (QASs).

An ad-hoc working-group was set up to support the activities of the project. The ABMs gap mapping analysis and the assessment of the level of penetration of the concept and of the use of ABMs were outsourced. The exercise consisted of a methodological review of the identified sources/documents and extraction of data to populate ad-hoc data models. The analysis of the data was carried out pursuing a step-wise statistical approach. The results were presented to a group of experts that were stimulated by an external facilitator to discuss them and to carry out a brainstorming analysis on what has been achieved and what is still missing on the use of ABMs. By applying a philosophical approach, experts were invited to “think in new boxes” (De Brabandere and Ivy, 2013) in order to: i) identify the relevant activities that are needed to fill the gaps and ii) propose strategies and actions to improve the knowledge on the use of ABMs as “diagnostic tests” in animal welfare.

Proposals for enhancing and spreading the use of ABMs among the stakeholders and the interested parties, and potential activities to further develop quantitative risk assessment methodologies in animal welfare by using ABMs, also resulted from the brainstorming exercise.

The main outcomes of the project were: i) the need to standardise and harmonise the terminology to refer to ABMs, as a general concept and as specific tools, in order to make easier their use and then the communication among stakeholders; ii) the gap between scientific development of specific ABMs and their practical use, which makes it difficult to obtain and share data and to get access to good quality and harmonised data to be used in EFSA’s risk assessments; iii) the need to create an AW community driven by ABMs in which all stakeholders and interested parties are motivated to use and share information on ABMs and contribute to the data flow from the animal to scientists and other users; iv) data need to be collected and collated in a common data repository that could feed the analyses of all stakeholders according to their purposes.

On these bases it would be important to re-assess the role that EFSA plays, and may play, in the AW community, in order to enhance and spread the use of ABMs among stakeholders and interested parties, and develop quantitative risk assessment methodologies in animal welfare by using ABMs. The outcomes of the project should help EFSA in defining and channelling the resources to be invested for further projects in animal welfare.
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1. Introduction

1.1. Background and Terms of Reference as provided by EFSA

1.1.1. Background

Animal welfare is nowadays of important concern for risk assessors, decision makers, consumers and public opinion across Europe, and there is clearly a strong demand for higher animal welfare standards: food quality is considered to be not only determined by the overall nature and safety of the end product but also by the perceived welfare status of the animals from which the food is produced.

Over the last ten years, the approach to animal welfare has radically changed: the use of animal-based measures (ABMs) to assess animal welfare has been introduced, and diverse research projects focus on this. Such measures are also considered in recent EU animal welfare legislation (Council Directive 2007/43/EC and Council Regulation (EC) No 1099/2009)\(^1\)\(^2\) and in assurance schemes (e.g. AssureWel\(^3\)).

Previous assessments relied mainly on resource- and management-based parameters ("input assessments"), while the use of ABMs aims to measure the actual welfare status of the animal directly ("outcome assessment") and thus include the effect of resource- and management-based factors.

The EU Strategy for the protection and welfare of animals (2012-2015)\(^4\), envisages a new EU legislative framework for animal welfare that may include the use of scientifically validated animal welfare outcome-based indicators to complement prescriptive requirements, simplify the legal framework and allow flexibility to improve competitiveness of livestock producers.

Additionally, the International Standard Organisation (ISO) is working jointly with the World Organisation for Animal Health (OIE) in order to develop International standards or an ISO technical specification for animal welfare based on the OIE guidelines of the Terrestrial Animal Health Code\(^5\). The proposed outlines of this cooperation include the development of an animal welfare threshold for animal-based criteria.

In this context, EU has funded several research projects in the field of animal welfare outcome assessment (e.g. Welfare Quality\(^6\)). Moreover, the European Commission requested EFSA to produce scientific opinions on the use of ABMs to assess the welfare of different farm animals (EFSA AHAW Panel, 2012a, b, c). In developing these scientific opinions, EFSA contracted scientific studies to analyse the relationships between the previous "input-based assessment" and the new "outcome-based" one, and to review the methodologies applicable to the validation of ABMs (Presi and Reist, 2011; Brenninkmeyer and Winckler, 2012).

The EFSA AHAW Panel has published a statement which provides guidance on the use of ABMs to assess the welfare of animals (EFSA AHAW Panel, 2012d). The document particularly highlights that carefully selected combinations of ABMs can be used as valuable tools for assessing the welfare of animals in a valid and robust way. A technical meeting with stakeholders and interested parties was organised with the aim to review the ABMs that are already used in the EU by different actors along the food chain and from different sources, and to discuss the validity and the feasibility to collect them in a systematic way (EFSA, 2012). Additionally, EFSA has funded a project, involving several EU Member States, as a proof of concept study of the possibility of using routinely collected ABMs to evaluate the overall animal welfare in dairy cows (ANIBAM, Nielsen et al., 2014).

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3 http://www.assurewel.org/aboutassurewel
5 http://www.oie.int/en/international-standard-setting/terrestrial-code/
6 http://www.welfarequality.net/everyone
All these EU-funded projects and scientific outputs have improved our scientific understanding of the use of ABMs and facilitated collaboration between scientists, risk managers and interested parties. ABMs have been identified as possible tools to be used as “diagnostic tests” for animal welfare. The aim of EFSA to assess the welfare of the animals by using a quantitative risk assessment methodology has not been achieved yet.

With this in mind, EFSA considers it important to define the state of play on the use of ABMs - what has been achieved, what is still missing and which actions will be needed in order to optimise the resources for further projects in animal welfare and on the use of ABMs.

Therefore, a review and analysis of the research findings and quality assurance programs in the EU on the use of ABMs of the past ten years was carried out in order to define the state of art and identify the gaps that have been encountered. Additionally, it was considered useful to assess how the scientific outcomes have been included into the legislative framework.

1.1.2. Terms of reference

Terms of reference
1. Identify EU-funded projects, peer-reviewed papers, legislation, quality assurance schemes and training programmes developed in the EU in the last 10 years that used ABMs to assess the welfare of animals; assess the level of penetration of the concept and the use of ABMs in the scientific community, among stakeholders and interested parties, identify and describe the main gaps (“gap mapping”).

2. Identify relevant activities to fill the identified gaps in order to improve the knowledge in ABMs so that they can be used as “diagnostic tests” to quantitatively assess the welfare of animals. This process should involve experts on the use of ABMs from the AHAW Panel, representatives of the scientific community, decision makers, animal welfare assessors, in order to discuss the results of the gap mapping (“gap analysis”).

1.2. Interpretation of the Terms of Reference

The overall objective of Term of reference (ToR) 1 is to assess the state of play on the use of ABMs to assess AW in the EU in the past ten years (2004-2014). Particularly, ToR 1 focuses on five animal-welfare related areas of interest (EU-funded projects, peer-reviewed papers; EU-legislative acts; Quality Assurance Schemes; EU-training initiatives) and aims to identify:

- How much the concept and the use of ABMs to assess the welfare of animals have penetrated the AW Community in the EU; an assessment of the level of penetration could be represented for example by the number of EU-research projects, peer-reviewed papers, EU-legislative acts, quality assurance schemes and EU-training initiatives in which ABMs are included, compared to the total AW ones of each category;
- Which are the main gaps related to the concept and use of ABMs in the areas of interest that may have affected the use of ABMs as “diagnostic tests” in animal welfare.

ToR 2 aims to define how the identified ABMs’ gaps may be filled and which activities could be carried out in order to improve the knowledge in the use of ABMs as “diagnostic tests” for animal welfare.

EFSA has defined an “animal-based measure” as a response of an animal or an effect on an animal used to assess its welfare. It can be taken directly on the animal or indirectly and includes the use of animal records (EFSA, 2012d). However, with the term “animal-based measure” one could refer to the general concept or to a specific use (specific measure).

The ABM’s concept refers to the use of the specific wording “animal-based measure(s)”, or one of the synonyms, when describing welfare assessment methodologies or interpretation. It could be viewed as representing a “toolbox” from which to select the range of specific ABMs (“tools”) to be used for addressing the objective of the assessment, as fit for the purpose.

A specific ABM is a measure of a response which can result from a specific event, e.g. an “injury”, “mortality”, or be the cumulative outcome of many days, weeks or months, e.g. “body condition”, “lameness”.

www.efsa.europa.eu/publications 6 EFSA Supporting publication 2015: EN-884
2. Approach to answer the Terms of Reference

An EFSA ad hoc working group of experts (WG) was set up to support the activities that were needed for the project development.

In order to answer ToR1, a list of data needing to be collected was defined and the following activities were performed:

- Identification of the sources to be taken into account and scrutinised and where the data should be extracted from, within each of the five animal-welfare related areas of interest (EU-funded projects, peer-reviewed papers, EU-legislative acts, quality assurance schemes and EU-training initiatives) that include ABMs (Section 3.1).
- Definition of the methodology for assessing how the concept and use of ABMs have penetrated the AW community in the EU (Section 3.2).
- Definition of the methodology for identifying the gaps and design of data models that were populated with the data extracted from the identified sources. The data models were the basis for identifying, mapping and analysing the gaps (Section 3.3.1).

These tasks were outsourced and their implementation was monitored in close collaboration with EFSA scientific support and the WG members.

In order to address ToR2, the identified gaps were presented and analysed in a specific WG meeting extended to other representatives of the AW scientific community, decision makers, stakeholders and interested parties particularly involved and experts on the use of ABMs.

The meeting was moderated by an external facilitator to stimulate the discussion of the results of ToR 1 and the analysis of the achievements and gaps regarding the use of ABMs.

Experts were asked to: i) identify the relevant activities that are needed to fill the gaps and ii) propose strategies and actions to improve the knowledge on the use of ABMs as “diagnostic tests” in animal welfare.

Proposals for enhancing and spreading the use of ABMs among the stakeholders and the interested parties, and potential activities to further develop quantitative risk assessment methodologies in animal welfare by using ABMs, also resulted from the brainstorming exercise.

The results of the analysis carried out by the experts are reported in Sections 3.3.2 and 3.4.

3. Assessment

3.1. Sources identification

In order to address ToR 1 it was necessary to identify, within each of the five animal-welfare related areas of interest, the relevant sources to be taken into account and analysed. The results of this exercise are listed below (for more details of the sources’ materials and methodologies, please refer to Gottardo et al., in press).

It needs to be highlighted that in the case of EU-funded projects, EU-legislative acts and QASs a limited number of selected example sources was assessed and the resulting data aim to be used for having a “snapshot” of the situation; whereas in the case of peer-reviewed papers, which were identified through a scientific protocol, the resulting data analysis can be considered more significant, representative and reproducible.

1. EU-funded projects: ten EU-funded projects on animal welfare were taken into consideration for the purpose of this project, and a total number of 24 relevant documents were assessed and the data extracted from. The criteria to select the projects were: i) reported between 2004 and 2014, and ii) having animal welfare as the major topic of investigation.

2. Peer-reviewed papers: a scientific literature search protocol using Web of ScienceTM - Thomson Reuters (Database Web of ScienceTM) was applied. A total number of 147 records resulted from
the scoping search; according to the protocol, a subsequent manual screening was performed by three qualified assessors and 89 papers were selected for further analysis and data extraction. For the exact search criteria please refer to Gottardo et al. (in press).

3. **EU-legislative acts**: nine documents were taken into account for the assessment. The criteria to select the acts were: i) published between 2004 and 2014, and ii) having animal welfare as the major topic or as a component.

4. **Quality Assurance schemes (QASs)**: six QASs on AW were considered; a total number of 33 documents were assessed; relevant data were extracted and analysed further. The criteria to select the schemes were: i) having animal welfare as a major scheme component, and ii) having a website with documentation in English language.

5. **EU-training initiatives**: several EU-funded training initiatives on AW were taken into consideration for the aim of the project. However, relevant documents were difficult to retrieve and necessary data were not available. This precluded the possibility of further analyses.

For the aim of the project, the level of penetration of ABMs in these data sets was assessed for the first four areas of interest, whereas the gap mapping analysis focused on the EU-funded projects, peer-reviewed papers and QASs.

### 3.2. Assessment of the level of penetration of ABMs in AW

How the concept and the use of ABMs have penetrated the AW community were quantified for four animal-welfare related areas of interest: EU-funded projects, peer-reviewed papers, EU-legislative acts and QAS.

The data reported in the following sections are those resulting from the assessment outsourced to Gottardo et al. (in press).

#### 3.2.1. EU-funded projects

Eight out of 10 EU-funded projects assessed had documents with general ABMs terms (80%) and 6 of them included specific ABMs (75%).

Out of the 24 documents assessed, 19 referred to specific ABMs (79%).

#### 3.2.2. Peer-reviewed papers

Two approaches were followed for calculating respectively the level of penetration of the concept and the use of ABMs in the scientific literature.

1. The level of penetration of the **general ABM's concept** in AW scientific publications was 0.79%. It was calculated with the following ratio:

   147 records resulting from the scientific literature search containing the general ABM’s concept (and synonyms)/Number of records containing the exact phrase “animal welfare” (approximately 18,646).

   This ratio didn’t change substantially when the search string of the denominator was not required to contain the exact phrase “animal welfare”, but only these words somewhere in the title, abstract and keywords (animal welfare-unquoted; 0.76%) or the word “welfare” by itself (0.72%).

2. The level of penetration of **specific ABMs** was investigated *a posteriori*:

   A new scoping literature search was performed on the records containing the exact phrase “animal welfare” (approximately 18646) using the specific ABMs that occurred at least 10 times in the 89 papers selected after manual screening of the records resulting from the first literature search. The total number of records found was 1,782. The ratio was calculated as 1,782/18,646= 9.56%

   This ratio didn’t change substantially when the search string for numerator and denominator referred to animal welfare-unquoted (9.26%).

From these figures the penetration of specific ABMs on the scientific literature resulted to be at least 12 times higher than the one of the general ABM’s concept.
3.2.3. EU-legislative acts

Occurrences of general ABM terms, AW and number of specific ABMs were extracted from 9 EU-legislative acts that were assessed.

Two acts contained the general ABM’s concept (22%), specifically: the EU-Strategy on animal welfare included one or more of the general ABM terms proposed in this study and, additionally, it contained also “welfare outcome” and “welfare indicator”, for a total of 4 different terms. These latter terms were found also in the Council Directive 2007/43/EC.

Eight out of the 9 EU-legislative acts assessed in this study contained specific ABMs (ratio: 89%).

It could be concluded that the concept of ABMs is scarcely present in the EU-legislative acts (22%) compared to the use of specific ABMs (89%), in fact, several specific ABMs were identified as requirements, especially in the Annexes of the documents. The reason might be that legislation needs practical assessment tools, suitable for all the stakeholders involved, more than general concepts.

3.2.4. Quality Assurance Schemes

Three of the six Quality Assurance Schemes (QASs) on AW that were analysed in the project considered the general ABMs’ terms (penetration level of the ABM’s concept=50%) and 5 included specific ABMs as requirements (penetration level of the use of ABMs=83%).

Among the assessed 33 technical documents of the QASs, six contained the general ABMs terms (18%) and 31 included specific ABMs (94%).

It could be concluded that the concept of ABMs is less present in the QASs (50%) in this study compared to the use of ABMs (83%). This can be explained by the scope of the Quality Assurance Schemes: they aim to provide protocols and instructions for practical assessment of the welfare of the animals in the field, and, in fact they reported several specific ABMs (153) as requirements.

How ABMs penetrate the AW community in the area of QAS could be also quantified on the basis of the number of operators registered under AW QASs that do not include ABMs in their standards, compared to the number of operators registered under the AW QASs requiring also ABMs. Unfortunately, this comparison among QASs could not be performed because the number of operators involved in the application of the technical documents was only retrieved for one of the analysed QASs (Red Tractor–UK).

3.3. Assessment of ABMs’ main gaps

3.3.1. Assessment of ABMs’ main gaps from the gap mapping analysis

ABMs’ main gaps were identified for the EU-funded projects, peer-reviewed papers and QASs. The exercise consisted of a methodological review of the identified sources/documents and extraction of data to populate ad-hoc data models.

The analysis of the extracted data to identify possible gaps related to the concept and the use of ABMs was carried out following a step-wise statistical approach (Gottardo et al., in press).

In this section, the main gaps identified and mapped by Gottardo et al. (in press) are listed together with the differences that were reported for the animal-related areas of interest that were investigated.

Penetration of ABMs in the AW community

In the case of peer-reviewed papers, EU-legislative acts and QASs, the general ABM’s concept seems to have penetrated less the AW community, compared to the use of ABMs. This is reported as a lower number of documents with the general ABM terms compared to the larger amount of documents on AW and containing specific ABMs.

In the case of EU-funded projects, the figure is turned around (for more details see previous Section 3.2 and Gottardo et al., in press).

In the case of QASs and legislative acts this can be explained by the fact that standards/requirements need to be practically assessed in the field.
The difference in focus between ABMs concept and use in the scientific publications (EU-funded project versus peer-reviewed papers) can be explained partially by the selection process of the sources to be assessed: in fact, the peer-reviewed papers were selected on the basis of a reproducible scientific search protocol. Additionally, the last ten years of EU-funded projects on animal welfare were focused on ABMs; whereas when publishing peer-reviewed papers authors do not feel the need to refer to the general ABM’s concept and the categorization of specific ABMs into the toolbox-general ABM’s concept may be given for granted.

**General ABM’s concept**

Heterogeneity in the use of the general ABM terms was identified mainly in the peer-reviewed papers. There was a lack of consistency in referring to the “toolbox-general ABM’s concept and several combinations of the terms which were used as synonyms (e.g. animal-based/animal-related/welfare-outcome/outcome-based/etc and measure(s), parameter(s), outcome(s), indicator(s)). However, “animal-based measure(s)” seems to be the most frequently used one at least in the case of peer-reviewed papers (56 papers out of the 89 selected ones (63%)) and also in the EU-funded projects (21 documents out of the 24 assessed (88%)).

In QASs, only 6 documents (18% of the assessed ones) included general ABMs term, and “welfare-outcome measure(s)” was the most frequently used (in 5 documents).

**Definition of the general ABM’s concept**

In EU-funded projects, 9 documents (of 3 different projects) provided a definition of the term for indicating the general ABMs concept (37% of the assessed documents).

Twenty-one percent of the selected papers did not contain any definition of the general ABM’s concept nor references to other sources (19 papers); 13 papers included a definition without providing reference to other sources (15%) and 64% (57 papers) referred to the definition provided by other sources. It’s important to highlight that EFSA’s scientific outputs are not included in the list of references that were cited more than twice as providing the definition of the term for the general ABM’s concept (see Table 1).

**Table 1:** List of references that were cited more than twice as providing the definition of the term indicating the general ABM’s concept and number of the selected peer-reviewed papers citing them

<table>
<thead>
<tr>
<th>Most cited documents for definition of the general ABMs term</th>
<th>Nº of peer-reviewed papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare Quality®, 2009</td>
<td>10</td>
</tr>
<tr>
<td>Whay et al., 2003</td>
<td>9</td>
</tr>
<tr>
<td>Main et al., 2003</td>
<td>5</td>
</tr>
<tr>
<td>Main et al., 2007</td>
<td>5</td>
</tr>
<tr>
<td>Keeling and Veissier, 2005</td>
<td>5</td>
</tr>
<tr>
<td>Webster et al., 2004</td>
<td>5</td>
</tr>
<tr>
<td>Winckler et al., 2003</td>
<td>3</td>
</tr>
</tbody>
</table>

In addition to the variability in the use of terms for the general ABM’s concept, it was evident that some general ABM terms were used in a misleading way in the selected papers, possibly resulting in ambiguity, for example:

- The terms “welfare indicators” and “standardized animal welfare indicators” were found in the text of the papers as referring to the general ABMs term (i.e. related to an animal-based outcome) but, when reading them isolated from the context, they might intend also resource- or management-based indicators;
- The terms “assessment tools” and “welfare outcome assessment” were found as referring to the general ABMs term but they might indicate an assessment scheme.
Only 15% of the assessed documents of QASs (5 documents from 2 QASs) provided a definition of the general ABMs term.

**Animal species considered**

On the basis of the gap mapping analysis results, some animal species have been scarcely taken into account by the AW community.

Cattle, swine and poultry were the more represented animal species in EU-funded projects, peer-reviewed papers and QASs, and other species were less or scarcely considered (e.g. sheep and goats; see Table 2 for reference).

Non terrestrial species were completely absent in the assessed scientific publications (EU-funded projects and peer-reviewed papers); whereas in the case of QASs, fish were represented in 6% of the retrieved papers. The reports considered Atlantic salmon and farmed rainbow trout only, and were published by RSPCA welfare standards, respectively in 2010 and 2014 (for more details, see Gottardo et al., in press).

**Table 2:** Percentages of the assessed documents/papers distributed according to the animal species considered.

<table>
<thead>
<tr>
<th>Animal species</th>
<th>EU-funded projects - % of documents</th>
<th>Peer-reviewed papers – % of papers</th>
<th>QASs – % of documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swine</td>
<td>25</td>
<td>33</td>
<td>50</td>
</tr>
<tr>
<td>Cattle</td>
<td>21</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>Poultry</td>
<td>21</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Equine</td>
<td>13</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Sheep</td>
<td>8</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Goat</td>
<td>4</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Fish</td>
<td>-</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Rabbit</td>
<td>-</td>
<td>-</td>
<td>3</td>
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<tr>
<td>Fur</td>
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<td>-</td>
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</tr>
</tbody>
</table>

**Scenarios considered**

On the basis of the results of the gap mapping analysis exercise, the majority of the documents and papers studied are related to “on-farm” assessment (see Table 3, and refer to Gottardo et al., in press, for more details).

**Table 3:** Percentages of documents/papers for each of the scenarios.

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>EU-funded projects - % of documents</th>
<th>Peer-reviewed papers – % of papers</th>
<th>QASs – % of documents</th>
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<tr>
<td>On-farm</td>
<td>33</td>
<td>85</td>
<td>43</td>
</tr>
<tr>
<td>During transport</td>
<td>25</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>At slaughter</td>
<td>-</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Combination of scenarios</td>
<td>29</td>
<td>6</td>
<td>51</td>
</tr>
<tr>
<td>Not reported</td>
<td>13</td>
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<td>-</td>
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In the case of QASs, 36% of the assessed documents combined the three scenarios, “on farm”, “during transport” and “at slaughter”, with the aim of following the entire production chain.

**Specific ABMs and their definition**

Heterogeneity in the use of the specific ABMs was identified in EU-funded projects, peer-reviewed papers and QASs (for more details, see Gottardo et al., in press).
A total number of 272 specific ABMs was identified from the 24 documents of the assessed EU-funded projects. The specific ABMs occurring at least 10 times were: “lameness”, “qualitative behaviour assessment”, “coughing”, “body condition score”, “panting” and “ocular discharge”. The number of specific ABMs for each animal category ranged from 11 (in the case of sheep) to 89 (fattening pigs) with an average value of 37.

Among the 89 peer-reviewed papers assessed, 80 contained specific ABMs. A high number of specific ABMs (755) was extracted (average number of specific ABMs per paper was 14, with a range from 1 to 115 per paper). The specific ABMs occurring at least 10 times were: “lameness”, “cleanliness”, “body condition score”, “mortality”, “avoidance distance”, “nasal discharge”, “coughing”, “qualitative behaviour assessment” and “skin condition”; however, it was reported that a wide number of terms were used to identify the same specific ABMs which could be considered as indicator of the heterogeneity of specific ABMs. It was also highlighted that there was difficulty in understanding whether specific ABMs were similar in the meaning and in the methods of measurements, because definitions were often missing (in 40% of the extracted specific ABMs) or not comparable.

In QASs, the number of specific ABMs identified in the 33 technical documents was 153 with an average number per technical document of 10 (range from 2 to 44). The most frequently used specific ABMs were: “mortality”, “death” and “body condition score”. No definitions were reported for 123 (80%) specific ABMs. The number of specific ABMs extracted varied for the different categories of animals: more than 20 were defined for lactating cows, fattening pigs, rabbit does, fattening rabbits, and sows, while other animal categories (e.g. calves, sheep and lambs) had a lower number of specific ABMs (<10).

Specific ABMs’ essential attributes and their definition

The essential attributes that were investigated in the assessed documents/report were the ones listed in EFSA’s Statement on the use of ABMs to assess AW (EFSA AHAW Panel, 2012d), i.e.: sensitivity, repeatability, reliability, specificity, validity, feasibility, robustness, accuracy and reproducibility.

In the case of EU-funded projects specific ABMs were assessed mainly for “reliability” (129), “feasibility” (109), “validity” (103) and “repeatability” (82), whereas “accuracy” and “specificity” were not reported. In the majority of cases the essential attributes that were assessed were defined according to EFSA (EFSA AHAW Panel, 2012d).

In peer-reviewed papers, specific ABMs were assessed mainly for “sensitivity” (164), “reliability” (151), “repeatability” (134), “specificity” (108) and “validity” (107). As an example, considering the specific ABMs occurring at least 10 times in the selected 89 peer-reviewed papers, “lameness” was the most frequent one assessed for its essential attributes, and mainly for its “reliability”. “Reliability” and “repeatability”, only, were defined according to EFSA’s definitions (EFSA AHAW Panel, 2012d) and in only 11 papers; however, in none of them was a citation to EFSA reported for the definition.

None of the 153 specific ABMs extracted from the QASs were assessed for the essential attributes. From the data reported, there is a lack of knowledge on specific ABMs essential attributes, which might be one of the causes that have prevented a quantitative assessment of AW by using ABMs.

Additional gaps

An additional gap that was encountered in the case of EU-funded projects and QASs (and that was the main limitation in the case of EU-training initiatives) was the retrieval of documents and information from the websites. A solution to this gap would be a centralised database (or platform) of the sources and relevant documents.

3.3.2. Assessment of ABMs’ main gaps from the experts’ discussion

The main points highlighted during the experts’ discussion on the results of the gaps’ mapping analysis are listed in the following sections.
Level of penetration and heterogeneity of ABMs

- There is a low level of penetration of ABMs at a practical level; there appears to be a gap between scientific development of specific ABMs and their practical use. This gap can be addressed by making ABMs more user-friendly and also by improving communication and training.

- There is a low penetration of ABMs at legislative level and mainly the general ABM’s concept has scarcely penetrated the EU-legislative acts.

- From the figures described by the gap mapping analysis exercise on the number of specific ABMs that have been developed and used for research findings and QASs, the impact of the scientific outcomes into the legislative framework seems to be low. This might be explained by the fact that legislation needs clear and homogeneous definitions of the requirements that are prescribed.

- There is confusion in the terminology and categorisation of ABMs resulting in a lack of precision and comparability, which may affect the level of penetration of ABMs in the AW community and their practical use.

- An assessment of the needs of different stakeholders, compared to the expectation and research aims, is useful for defining the actions are needed to enhance and spread the use of ABMs.

- Non-scientific users have the need for a simplification of the assessment tools:
  - Legislators need a selection of ABMs that can easily be implemented and that fit with the existing animal production systems. ABMs need to be suitable for all the stakeholders involved.
  - QASs’ assessors ask for ABMs that are well-defined and easy to be assessed.
  - Industry representatives ask for the use of “iceberg indicators” that can easily give a first overview of the AW situation (as a surveillance system) and can be used to identify the cases where a deeper assessment is needed.

- The lack of harmonization of terminology leads to difficulties in communication and has negative effects on the use of ABMs among all actors in the AW community.

- The use of ABMs is currently still not structured and standardised: a common platform or repository of ABMs’ data is considered useful for increasing homogeneity.

Specific ABMs’ essential attributes

- Validation is the way to evaluate the performance of the specific ABMs and to move to a quantitative assessment of risks in animal welfare. It appears that here is some difficulty in validating all the specific ABMs already developed. They may be not fit for all the purposes and scenarios (e.g. systems, animal species, categories…). To remedy this, it would be best to start validating the tools that are most feasible and practicable.

Data on ABMs

- Several data on AW assessments using ABMs have been produced in scientific studies; however, these data are frequently not harmonised, not collected in a standardised way or with compatible standards and, therefore, not comparable. This limits the possibility of performing a quantitative risk assessment and is also a missed opportunity for optimising resources.

3.4. Main outcomes from experts’ brainstorming on ABMs

The main actions and tasks that were identified by the experts in order to fill the gaps, enhance and spread the use of ABMs among stakeholders and interested parties, and develop quantitative risk assessment methodologies in animal welfare by using ABMs are reported in this section.

3.4.1. Creation of an AW community based on ABMs

During the guided brainstorming, the process of “Induction”, carried out by the experts led them to “think in new boxes” (De Brabandere and Iny, 2013). This resulted in a perceived change of ABM status: previously they were “tools for a purpose” (e.g. tools for evaluating mortality, culling rate,
etc.; in the new representation they are a “value” (bitcoin) sharable among all the actors of the AW community (see Figure 1).

It can be argued that scientists seemed to be completely detached from other users/stakeholders with the difficulty of collecting good quality data on ABMs (bottom left side of Figure 1 – “old box”). The change of view requires them to look at animals together with farmers, risk assessors, QASs’ assessors, legislators and the other stakeholders (top left side of Figure 1 – “new box”).

**Figure 1:** Scheme of induction into an AW community through ABMs

In this future prospective, where welfare community could be based on ABMs as the “bitcoin” of AW, it is important also to think about the role scientists should play for making this community work. Two actions resulted to be the keywords in this: “communication of the information” and “translation of the information for the different actors”; for one side it is necessary to motivate stakeholders in using ABMs, on the other side it is needed to make ABMs more user friendly, targeting them on the needs of different users.

Once the idea of an ABM welfare community is established, there is the need to understand how it could work (see Figure 2).

According to industry and other stakeholders’ needs, specific ABMs can be used as “iceberg indicators”, for a first-line surveillance of the AW. The ABMs that are used may also differ according to context, animal species and life stage of the animal; therefore, different data models, where data flow throughout all the providers and users of ABMs, may be created. For populating the data model(s), relevant training and informative activities are needed.

After creating the data model(s), or a data repository where all the information can be stored and shared, they can feed the analyses on the use of ABMs (AW assessments) or on the general ABM’s concept with the data that are fit for the specific purpose.

In this AW community picture, it would be relevant to clearly define which role EFSA may play.
3.4.2. Definition of a data flow on ABMs to assess AW

One of the main outcomes of the project is that an ABMs’ welfare community can be built up which could support EFSA to collect data to be used in its risk assessments.

In order to enable EFSA to get access to good quality data, it would be necessary to motivate providers “to want” ABMs as well as to pass information to the next step of the chain up to EFSA (Figure 3 shows how ABMs’ information could flow from the animal to EFSA).

Starting from the bottom of the figure, the animal is the original source of the information about its welfare. The animal gives up its information (in the form of ABMs) to the farmer or to an assessor while it is still on the farm (directly or through some automated recording) or it can give up its information at the slaughterhouse. The assessor or the Food Business Operator (FBO) of the slaughterhouse may be official (and required to give the data directly to the Competent Authority in their country (CA of the Member State)) or private (part of a QAS).

The farmers, assessors and FBOs would probably gather only the information they are interested in.

However, the farmer could be motivated to allow the private assessor or the FBO to even collect data by getting some benefit. This benefit could be represented by the chance to get some information back from them, information that the farmer could not collect alone and that could be used for improving the welfare of the animals and the efficiency of the farm. The extent of that improvement is detected the next time the ABM is assessed in that farm. In this case, data could also be retrieved by FBO and assessor from the farmer.

The assessor and the FBO may use the data they have collected according to their own needs; one need could be the ability to gather data required by the national legislation to pass to CAs; in this case, there should be a feedback from the CA.

QASs will have the information from the farmer and the FBO that are registered under the assurance scheme, and will pass its information on to the retailer (if it is not the retailer’s own scheme) who will use it for its own needs. One need of the retailer may be to pass some of this information on to the consumer. It will probably also use it in its own marketing and management decisions. Some auditors in some QAS pass data to their Member State (MS; hence the dashed line).
MSs use the ABMs’ data for their own needs: e.g. to formulate legislation or in control programs to check if legislative requirements have been enforced. This information may be transferred to the European Commission.

An additional need of the Member State may be to provide the information to EFSA.

Also researchers may pass the information gathered from the animal (directly or indirectly, through farmers, assessors and FBOs, to whom a feedback should be given) to EFSA.

For specific mandates EFSA may even want to link ABMs to other outcome measures e.g. human health, and so would get data from other Authorities (e.g., ECDC).

Data flow also from EFSA and other Authorities to European Commission.

What is clear from this figure is that different actors in the potential chain have different needs; therefore, they want ABM data of different types or of different levels of detail.

The risk of an uncontrolled flow of the data is that information (quantity or quality of data) is lost as it moves up the chain. At each level there also may be some further processing to link the ABM information with other information that the actor is interested in (animal welfare assessment, production, economics, market demand etc), which may or not be interesting to move up the chain also. Again it is important to remember that each actor is only interested in receiving ABM information that is relevant for them.

It would be interesting to define the complete flow of ABM data, identify which nodes indeed do not provide information to lower layers (e.g. consumer node, from Figure 3) and further investigate these elements. The flow of ABM data is generated by the animal; this implies that all the quality of data for all the “upper” layers heavily depends on how data are collected by the “first-line” nodes: farmer, assessors, FBOs at slaughterhouses and researchers. The quality of the collected data strongly depends also on training, protocols and tools.

All this system of data collection could represent a resource for EFSA which could use the data for research and to move to a quantitative risk assessment of animal welfare.
Figure 3: Potential flow of ABM data from the animal to along the chain. Red wider arrows: flow of the data; blue narrower arrows: feedback from upper layer; dashed arrows: probable flow of data.
4. Conclusions

- There is evidence of a low penetration of the concept of ABMs in animal welfare. This is illustrated by a low representation in scientific publications and in the legislative framework that have been studied for this project.

- There is a gap between the scientific development of specific ABMs and their practical use: different stakeholders may ask for different ABMs, fit for their purposes.

- There is heterogeneity in the use of terminology and in the categorizing ABMs in scientific research. This leads to a lack of precision that may affect the communication to stakeholders (that needs simplification) and has negative effects on the level of penetration of ABMs in the AW community and on their practical use.

- There is still a lack of knowledge on the use of ABMs for certain species and in different scenarios. The essential attributes of ABMs also need to be further investigated.

- It is not easy to retrieve documents, reports, training proceedings regarding ABMs. This information is not readily available.

- The flow of ABM data is generated by the animal; this implies that all the quality of data for the “upper” layers heavily depends on how data are collected by the “first-line” nodes: farmers, assessors, FBOs at slaughterhouses and researchers. The quality of the collected data strongly depends also on training, protocols and tools.

- At the moment there is no structured “flow” of data from the animal to EFSA.

- Feedback from every level in the data flow process to the level preceding it is important to motivate the continued supply of information down the stream. However, what needs to be taken into account is that possibilities to act on the feedback at each level are different between actors.

- ABMs can be considered the bit coin of animal welfare, as an information currency that facilitates the creation of an AW community.

5. Recommendations

- To enhance and spread the use of ABMs among stakeholders and interested parties several actions should be put in place: i) increase and simplify the communication (including training) and translation of the scientific findings to stakeholders; ii) make ABMs more user-friendly and fit for purpose; iii) identify well-defined and practically used ice-berg indicators.

- To involve all the stakeholders of the food chain in the use of ABMs and overcoming the gap between science and practice, the benefits to them of using ABMs should be evident and shown.

- Guidelines for harmonising research on ABMs and reporting methodologies in scientific papers should be produced. The guideline should provide homogenous terminology, definitions and procedures for data collection. EFSA can play a central role in their development.

- Research into the use of ABMs needs to continue in order to increase the knowledge of specific ABMs in different species and scenarios, and should include the study of essential attributes. The results will support EFSA to move to a quantitative risk assessment of AW.

- A centralised database (platform) should be created where information on ABMs, sources and relevant documents, can be stored and shared. This platform would also promote communication and collaboration among scientists and with stakeholders.

- A data repository where stakeholders can submit data and where all the ABM data are stored to be used for the different purposes should be built up and regularly updated. This database can become a major source of information for EFSA’s risk assessment activities. EFSA should therefore be a primary stakeholder in its development.

- An information flow should be defined and promoted in order to get data from the providers (stakeholders) along the chain. However, there is the need to make the ABM data “flow” along the chain by getting the data from every actor that is involved and could provide them.
• The ABM information flow should be defined and promoted by EFSA in order to exchange information on ABMs between the providers (stakeholders). As part of this process is necessary to motivate every actor in the chain to get the data from the level before them.

• New ABMs data collection tools and protocols should be analysed in order to enhance data collection quality at first-line data collection layer: from the animal to farmers, assessors, FBOs at slaughterhouses and researchers.

• EFSA should actively participate and feed the AW community by playing a role in the actions that are fundamental for improving the use and the knowledge of ABMs (e.g. training, data repository, research promotion).
References


Gottardo F, Contiero B and Brscic M, in press. The use of animal-based measures to assess animal welfare in the EU – state of art of the last 10 years of activities and analysis of the gaps. Preparatory work. EFSA supporting publication.


Glossary

Animal-based measure: a response of an animal or an effect on an animal used to assess its welfare. It can be taken directly on the animal or indirectly and includes the use of animal records.

Gap mapping analysis: a process that includes the identification of the gaps, association with the areas of interest and statistical analysis.

General ABM’s concept: it refers to the use of the specific wording “animal-based measure(s)”, or one of the synonyms, when describing welfare assessment methodologies or interpretation. It could be viewed as representing a “toolbox” from which to select the range of specific ABMs (“tools”) to be used for addressing the objective of the assessment, as fit for the purpose.

Specific animal-based measure: a response which can result from a specific event, e.g. an “injury”, “mortality”, or be the cumulative outcome of many days, weeks or months, e.g. “body condition”, “lameness”.

Synonyms of the general ABM’s concept: other wording that could identify the ABMs “toolbox”, e.g. animal-based indicator, outcome-based parameter, animal-related indicator, etc.

Abbreviations

ABM(s): Animal Based or animal-based measure(s)

ANIBAM project: project on the use of animal-based measures for the assessment of dairy cow welfare

AW: Animal Welfare

BCS: Body Condition Score

CA(s): Competent Authority(-ies)

EC: European Commission

ECDC: European Centre for Disease Prevention and Control

EU: European Union

FBO: Food Business Operator

ISO: International Standard Organization

MS(s): Member state(s)

OIE: World Organization for Animal Health

QAS(s): Quality Assurance Scheme(s)

WG: working group