D2.1: REPORT ON VALID AWI FOR PIGS AND BROILERS, ON FARM, LOADING, TRANSPORT AND AT SLAUGHTER

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ABSTRACT

aWISH project aims to develop and offer a cost-efficient solution to evaluate and improve the welfare of meat-producing livestock at a large scale, across Europe. This approach will be developed and evaluated in close collaboration with all actors involved, from primary producers up to policymakers and citizens.

aWISH

ANIMAL WELFARE INDICATORS AT THE SLAUGHTERHOUSE

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THE SLAUGHTERHOUSE

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TABLE OF CONTENTS

ANIMAL WELFARE INDICATORS AT
THE SLAUGHTERHOUSE

TABLE OF TABLES & FIGURES

GLOSSARY OF ACRONYMS

Acronym / Term	Description
WPs	Work packages
CO_2	Carbon dioxide
NH_3	Ammonia
TRL	Technology Readiness Levels

DELIVERABLE ABSTRACT

Animal welfare is a multidimensional concept covering many different aspects of the life of an animal. The current deliverable contains lists of animal welfare indicators and their measures for pig and broilers, to be used in work packages 3-5 in the aWISH project. To give a structure to the indicators they are divided up into the five domains (Good feeding, Good housing, Good health, Appropriate behaviour and the Mental domain), but also the welfare consequences proposed by EFSA. To gather the data two systematic reviews were done. In total 136 indicators for pigs and 65 indicators for broilers were found. For both species the majority of indicators were found for on-farm animal welfare challenges (55% for the pigs and 65% for the broilers). While most welfare indicators were related to challenges occurring on-farm, most of the measures for the indicators were taken at slaughter. The domain for which most indicators were found was Good health, this was especially true for broilers in which approximately 80% of the indicators were indicators of Good health, the corresponding number for pigs was close to 30%. The validity of the indicators that were measured was in most cases supported by the literature. In the literature there is less information about the repeatability and generality of the measures (e.g. possible differences between breeds or sexes).

1. EXECUTIVE SUMMARY

The aim of the deliverable 2.1 is to identify valid indicators for animal welfare as well as ways to measure these on-farm, at transport and in the slaughterhouse. These indicators, together with the practical information gathered in other work packages of the aWISH project, are to be used in the development of an animal welfare indicator catalogue to be presented at the end of the aWISH project.

Animal welfare is a multidimensional concept. To be able to measure it accurately many different aspects need to be taken into account. To ensure that as many aspects as possible are included we have structured the result of the work according to the five domains model of Mellor (2015). This model suggests that animal welfare can be regarded as the function of Good feeding, Good housing, Good health and Appropriate behaviour which all feed into the Mental domain. In this approach both positive and negative aspects of animal welfare are included. An alternative approach classifying more explicit welfare problems has been used by EFSA (e.g. EFSA 2022). The indicators included in the deliverable have also been classified according to the welfare consequences of EFSA.

A systematic review was done using Web of Science, Scopus and PubMed. All duplicates as well as non-relevant articles were excluded, resulting in 118 articles for pigs and 70 articles for broilers. In total 136 indicators were identified for pigs and 65 for broilers. The production phase where the welfare challenge was developed, as well as the phase in which it was measured were identified from the study. In addition, the possible alternative phases for the development of the problem and for measuring it were identified, these are however based on the assessment of the project participants. The validity, feasibility and possibility of automatization were also assessed by the project participants.

The majority of the studies investigated indicators for on farm challenges (pigs: 55%, broilers: 65%). Most of the measures were however taken at slaughter, approximately 50% for pigs and 60% for broilers. There was an imbalance between domains with most of the indicators belonging to the domain Good health, this was especially true for broilers for which approximately 80% of the indicators belonged to this domain. Appropriate behaviour was a domain that had very few indicators for both pigs and broilers.

If the indicators instead are divided according to welfare consequences, then for broilers the three most common welfare consequences were indicators of levels of consciousness, locomotory disorders and soft tissue lesions and integument damages. For pigs the welfare consequences for which there were most indicators were: undefined stress, handling stress, and soft tissue lesions and integument damages.
The most common measure used in the studies was direct observations, 66 out of 136 for pigs, 25 out of 65 for broilers.

Although there is a large number of different indicators there is a concentration on indicators related to good health at the expense of other areas of concern, not least appropriate behaviour. There are also very few indicators for positive emotions. Developing further measures and indicators for these areas would ensure a more comprehensive view of the welfare of the animals.
The method for assessing the indicator was in most cases direct observations, something that is costly and time consuming, and the aim of aWISH to introduce a higher degree of automatization therefore seems logical. Developing and validating such methods is the primary aim of aWISH.

2. INTRODUCTION

Animal welfare is a multidimensional concept covering many different aspects of the life of an animal. While there has been a search for single indicators that may cover animal welfare in general, animal welfare protocols typically consist of a number of different indicators, measuring each of the different aspects.

The different aspects of animal welfare may be categorized in different ways. An influential approach has been the five domains model of Mellor and Beausoleil (2015). The model contains the four principles of Welfare Quality© (Botreau et al., 2009), but adds a fifth. The five are Good feeding, Good housing, Good health, Appropriate behaviour and the Mental domain. While the five domains model focuses on the overall welfare of the animals, and thus includes both the positive as well as the negative experiences of the animals, other approaches to assess animal welfare focus solely on the negative aspects, as is the case for the welfare consequences described by EFSA (2022). While the approach taken by EFSA is limited to adverse effects on the welfare of the animal it is also more detailed than the five domains model. Both approaches will therefore be used in this document.

Animals may experience different welfare challenges during different phases of their life. Studies of animal welfare indicators are often situation specific, both because of the aforementioned differences in the challenges, but also because of practical issues. In the current document we are dividing them up into measures of animal welfare on farm, loading, transport and at slaughter.

The indicators themselves may however be measured in other phases than the one in which the welfare challenge occurred. In many instances the most efficient place in which to measure an animal-based indicator may be at the slaughterhouse, since almost all animals pass through there.

2.1 OBJECTIVE

This deliverable D2.1 "Report on valid AWI for pigs and broilers, on farm, loading, transport and at slaughter" is a part of WP2 "Animal welfare indicators and catalogue" specifically Task 2.1 "List of valid AWI for fattening pigs and broiler chickens".

The main objective of this deliverable is to review the scientific literature on indicators of animal welfare in slaughter pigs and broilers, including all the stages of production. We report on the validity of the indicators, in which production phase the welfare challenge occurs as well as in which phase the indicator may be measured.

2.2 LINK TO OTHER TASKS OR WPS

The systematic review of the welfare indicators was used as a basis for Task 2.2. For a large number of the indicators there is insufficient information on the validity, either of the indicator or of the measure. The information on the level of validity will help in deciding the exact procedures of WP3 (for validation of the measurement) and WP4 (for validation of the indicator).

3. METHODOLOGY

The method for creating the list was a systematic review of measures for broilers and pigs. Apart from the systematic review project partners in aWISH could also add single measures that are currently being investigated, but which are not in the scientific literature (these are clearly marked in the Comments column in the list in the Appendices). For both species three different databases were used: Web of Science, Scopus and PubMed.

In addition to the search terms the following criteria should also be met:

• Terms should appear, at least, in title, abstract or keywords.

• Only articles written in English are included.

• Period of publication: 2000 to present

The lists from the searches contain the following information:

- The production phase in which the problem developed
- Where it was measured (on-farm, transport or at slaughter)
- What the welfare domain is
- What the welfare consequence are
- The type of indicator (e.g. skin lesions, gait score or activity)
- Our assessment of the validity of the indicator
- The method used for measuring the indicator
- Our assessment of the validity of the measure
- Our estimate of the feasibility of the measure
- Whether it can be used for other purposes than welfare assessment
- The technology used in the study
- The relevant references on which the information is based

3.1 THE PIG SEARCH

The search included the following terms and Boolean operators:

(indicator* OR measure)
AND
(evaluat* OR validat* OR assess* OR audit OR test* OR measure*)
AND
("animal welfare" OR "pig welfare" OR welfare)
AND
(slaughter* OR abattoir OR mortem* OR farm* OR transport)
AND

(pig OR sow OR piglet OR weaner OR fatten* OR "sus scrofa domesticus" OR swine)
AND NOT
guinea

For pigs, the combined search yielded 987 articles after removing duplicates. Of these, 118 articles are included in the table. Reasons for excluding articles were: the paper was a review, or the focus was on other production animals or on another scientific field such as nutrition, pathologic, genetics or pharmacological trials, .

3.2 THE BROILER SEARCH

The search included the following terms and Boolean operators:

(indicator* OR measure)
AND
(evaluat* OR validat* OR assess* OR audit OR test* OR measure*)
AND
("animal welfare" OR "broiler welfare" OR welfare)
AND
(slaughter* OR abattoir OR mortem* OR farm* OR transport)
AND
(broiler* OR chicken*)

For broilers, the combined search yielded 673 articles after removing duplicates. Of these 70 articles are included in the table. Reasons for excluding articles were primarily that they were on other production animals (e.g. turkeys or layers), were general reviews including a wide variety of species, or on welfare from a consumer perspective.

3.3 REVISION OF THE RESULTING LISTS

After having constructed the lists, they were sent out to all participants in Task 2.1 for checking, revision, and approval.

4. RESULTS AND DISCUSSION

All the technologies encountered after performing the two searches -the systematic review and the commercial search- are summarised in two tables, one for pigs and one for broilers. These tables can be found as an Excel file in Annex 2 for pigs, and in Annex 3 for broilers.

4.1 PHASE OF THE WELFARE CHALLENGE AND ITS MEASUREMENT

The aim of the searches was to find studies that investigated indicators for welfare challenges that occur on farm, during transport and at slaughter. The majority of the studies investigated indicators for on farm challenges (pigs: 55%, broilers: 65%, Table 1 and 2). While the studies investigated the indicators in a specific phase (Figure 1) it is also possible that they may be used to assess welfare in other phases. As an example, although the presence of wounds has been studied as an on-farm indicator, it may also be used as an indicator during transport and lairage, especially if it is possible to distinguish between new and old wounds. One of the goals of the aWISH project is to be able to give feedback to each part of the production chain and it is therefore important to consider if it is indeed possible to determine when a given welfare consequence has occurred.

Table 1. Pig welfare indicators.

The first column contains the number of indicators of pig welfare for each phase. The second column contains our assessment of whether there are additional indicators that could also be used to assess welfare in this phase. The final column therefore contains the total number of possible indicators for a given phase.

	Indicators studied	Possible alternative indicators	Sum
On farm	75	2	77
During transport	30	12	42
Lairage	21	15	36
At slaughter	10	12	22

Table 2. Broiler welfare indicators.

The first column contains the number of indicators of broiler welfare for each phase. The second column contains our assessment of whether there are additional indicators that could also be used to assess welfare in this phase. The final column therefore contains the total number of possible indicators for a given phase.

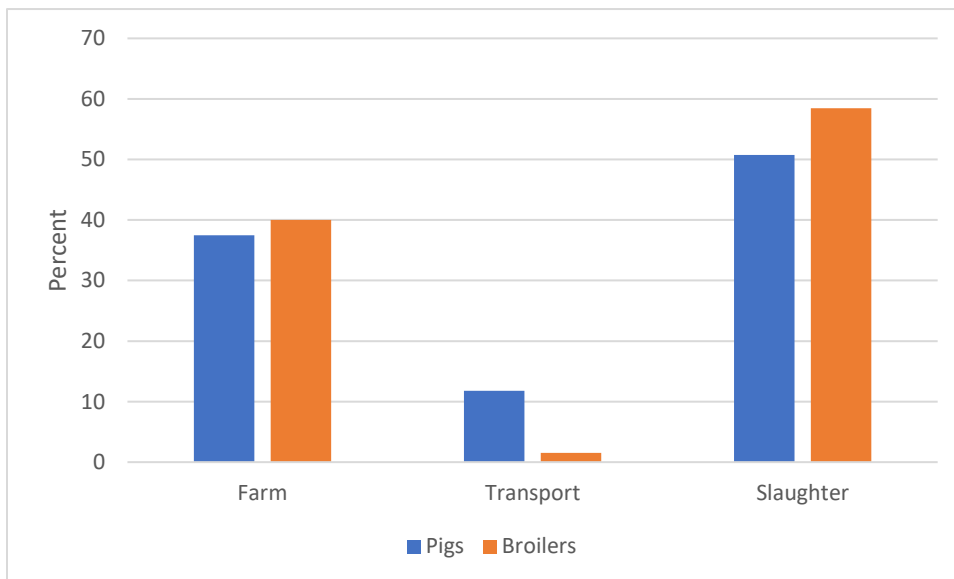|	Indicators studied	Possible alternative indicators	Sum
On farm	42	2	44
During transport	9	4	13
At slaughter	14	4	18

Figure 1. Phase in which the indicators are measured. The percentage of indicators that in the studies retrieved were measured on farm, during transport or at slaughter.

4.2 DOMAIN AND WELFARE CONSEQUENCES

In the tables from the reviews two different columns are used to identify the type of welfare challenges. One column contains our assessment of the indicator's relationship to the five domains model suggested by Mellor (e.g. in Mellor and Beausoleil., 2015) while the other contains the welfare consequences as categorised by EFSA (EFSA 2023), but with minor modifications. We have added one welfare consequence not used by EFSA: "Undefined stress". We have employed this term when the indicator is one of general stress e.g. cortisol.

One important distinction between the five domains model and the welfare consequences as defined by EFSA is the inclusion of positive welfare indicators in the former (Mellor and Beausoleil, 2015). Although there is currently much interest in the concept of positive welfare indicators, as well as research to find such indicators, very few examples have been found, many of which are probably hard to register automatically (e.g. play in pigs). In the current review only one has been proposed that may be measured automatically – vocalisations in broilers.

As can be seen in Figure 2 the domain for which there is the highest number of welfare indicators is Good health and this imbalance is extremely pronounced for broilers. For broilers the indicators of the three most common welfare consequences were indicators of levels of consciousness, locomotory disorders and soft tissue lesions and integument damages. For pigs the welfare consequences for which there were most indicators were: undefined stress, handling stress, and soft tissue lesions and integument damages (Table 3).
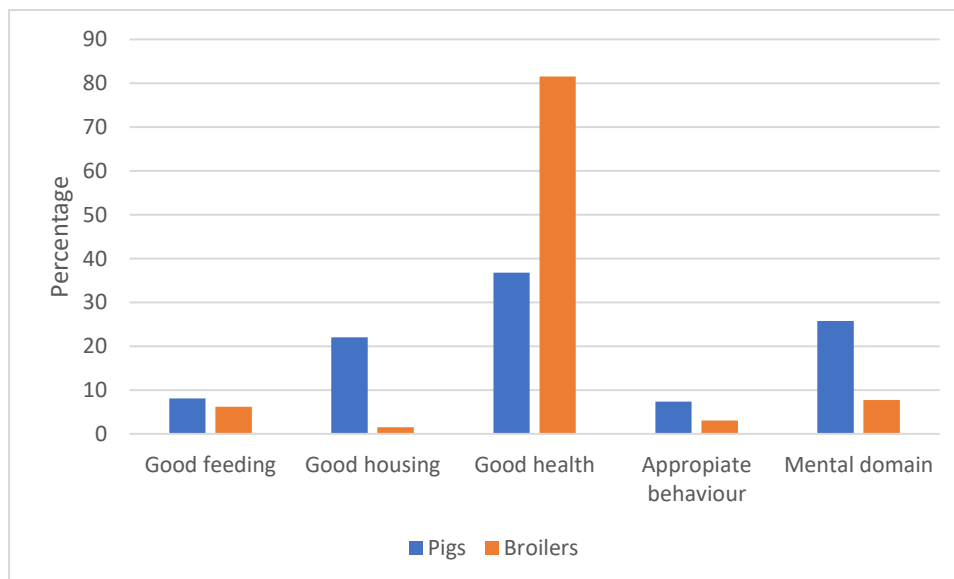

Figure 2. Percentage of indicators for each domain. The percentage of indicators found in the systematic review for each of the five domains of Mellor and Beausoleil (2015).

Table 3. The number of indicators for each welfare consequence.

Welfare consequence	Pigs	Broilers
Bone lesions	-	1
Cold stress	-	3
Disease	1	5
Environment discomfort	3	-
Gastro-enteric disorders	5	1
Group stress	9	-
Handling stress	14	-
Heat stress	9	2
Inability to perform play behaviour	1	-
Level of consciousness	10	14
Locomotory disorders	4	11
Muscle exhaustion	1	-
Positive emotions	-	2
Predation stress	-	1
Prolonged hunger	5	2
Prolonged hunger and thirst	4	-
Prolonged thirst	2	2
Respiratory disorders	8	-
Restricted movement	18	4
Soft tissue lesions and integument damage	13	12
Umbilical disorders and hernias	4	-
Undefined stress	25	5

4.3 INDICATORS AND METHOD

Most of the studies found in the review have used animal-based indicators. For pigs the only resource-based indicators included in the review are temperature, humidity, CO2 and NH3. For broilers management-based indicators such as stocking density, rejections at slaughter and culls on farm, were also included.

For pigs 40 out of the 136 indicators are behavioural indicators, with many of the others relating to lesions and physiological measures. Sixty-six of the 136 indicators in pigs were assessed through direct observations, with physiological measures being the second most common way of assessing the indicators (20 out of 136). The most common automatic method for assessing the indicators was a camera together with software/algorithm (14 out of 136).

For broilers close to half of the indicators (26 out of 65), were behavioural measures, ranging from visits to outdoor areas to corneal reflexes. The most common method employed for assessing the indicators was observation (25 out of 65), but also common was image analysis (12 out of 65). The image analysis together with cameras was most commonly used to assess patterns of activity thought to be related to gait score.

4.4 INDICATOR VALIDITY AND MEASUREMENT VALIDITY

In the review there are two different levels of validity. The first is related to the indicator itself and whether there is good scientific evidence for it being related to the welfare of the animal. The second concerns whether the measurement proposed is valid as it relates to the indicator. In the appendices our assessment of the level of validity is given using a three-point scale based on the references and experiments for both types of validity. Several of the indicators also have face validity, e.g., lesions or mortality. Our assessment of the validity is based on the studies, however reduction of the results of a number of studies to a single value is by necessity subjective, and these scores should therefore be treated with caution. In some instances, e.g. to measure the level of consciousness at slaughter, several indicators need to be combined, also making it difficult to give an overall score for the validity of an indicator or measure.

In general, the studies cite articles to motivate why the indicators are thought to be valid. While the measures are often correlated to other measures of the indicators, but it is much less common that e.g. intra- or interobserver reliability is included in the studies.

4.5 PRACTICALITY, AUTOMATIZATION, OTHER PURPOSES AND CLOSE TO COMPLETION

Because the reviews are based on scientific literature, they do not in most cases include finished commercial applications but are rather either basic science studies or pilot projects. For more information on measurements that are included in commercial applications see deliverable 2.2.

While the emphasis of the project is on measures that may be automatized there are also a number of measures that are taken for other purposes than animal welfare assessment. This may either be because legislation demands it or more often because it has economic consequences for the producer. Examples of this type of indicators are records on number of animals culled on farm and dead-on arrival.

4.6 POSSIBLE PITFALLS

It is important to note that a number of the columns in the appendices contains assessments that are based on our best estimate and should be taken as such. This is especially true for the assessments of indicator and measure validity, practicality and TRL. The two columns on validity both refer to whether the validity has been tested in the paper(s) cited, but some indicators may be well validated in other studies.

Likewise, some papers contain a correlation between two measurements (e.g. feather corticosterone and blood corticosterone) and the validity between these may be high but the paper may not have tested for the validity of corticosterone as a welfare measure. Finally, there are some indicators for which many studies have been published with conflicting findings about the validity (e.g. fluctuating asymmetry in broilers) and the value is then a subjective evaluation of the available evidence.

5. CONCLUSION

The result of the two reviews indicates that although there is a large number of indicators that have been investigated, they mainly focus on the welfare of the animals on-farm, while fewer indicators of welfare during transport have been developed. If aWISH is to develop an animal welfare protocol that covers all the production phases, then this suggests a need to invest some resources into this specific phase. If an indicator, e.g. heat stress, is deemed to be important in several phases, then the measures from one situation (e.g. on-farm) may be possible to adapt to other production phases with comparatively little effort, for example measures of temperature (with a thermometer or an IR camera), and possibly vocalisations. For some other measures, e.g. wounds, it is a question of being able to determine the age of the welfare consequence, and thus whether it happened on farm, or during transport/lairage.

While there is support for the validity of the indicators, there is less information on the reliability of the measures. This is especially worrying since the most common measurement method is direct observation. However even automatic measures will need to be tested under more than one condition for them to be a reliable alternative (e.g. using different breeds or different stocking densities), this may be an important task for WP3 of the aWISH project. Also because the reviews of this deliverable are based on the scientific literature most of the automatic measurements are best described as prototypes and have not been tested under commercial conditions.

For both species most indicators belong to the Good health domain, but this is especially true for the broilers. While good health is an important part of animal welfare, indicators of other domains, not least Appropriate behaviour, should be developed.

6. ANNEXES

6.3 ANNEX 1: LIST OF INDICATORS AND MEASURES FOR PIGS

Access to the Excelfile:
Pigs, systematic review

6.4 ANNEX 3: LIST OF INDICATORS AND MEASURES FOR BROILERS

Access to the Excelfile:
Broilers, systematic review

7. REFERENCES

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